



Effect of Bacterial pollination and mixing of different seeding rates of with *Trifolium alexandrinum* L. in growth and fodder *Hordeum vulgare* L. yield of Clover

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Abstract

The field experiment was conducted at the Second Agricultural Research Station affiliated with the College of Agriculture, Al-Muthanna University, in Al-Bandar village, southwest of Al-Muthanna Governorate, during the winter season of 2023–2024. The study aimed to evaluate the effect of bacterial inoculation on berseem clover, in combination with different barley (*Hordeum vulgare* L.) mixing ratios (25%, 50%, 75%, and 100%) while maintaining a fixed seeding rate of berseem clover (*Trifolium alexandrinum* L.) at 40 kg ha⁻¹. The interaction between these factors was assessed in terms of growth characteristics and forage yield over five harvests, the experiment was implemented using a split-plot arrangement within a randomized complete block design (RCBD) with three replications. The results showed that the bacterial inoculation treatment significantly outperformed the others, recording the highest mean nitrogen concentration in the plant during the second harvest at 0.70%. Additionally, in the fourth harvest, it achieved the highest mean plant height (62.40 cm) and the highest number of branches per square meter (3,083 branches m⁻²), regarding the mixing ratios, the barley-only treatment in the second harvest recorded the highest mean nitrogen concentration in the plant at 0.97%. Moreover, the berseem-only treatment in the fourth harvest achieved the highest mean plant height (68.70 cm) and the highest number of branches (2,900 branches m⁻²). The (100% barley + berseem) treatment recorded the highest mean fresh forage yield at 86.60 tons ha⁻¹, whereas the barley-only treatment in the fourth harvest recorded the highest fresh forage yield at 11.35 tons ha⁻¹. Regarding the interaction between bacterial inoculation and mixing ratios, the combinations (berseem-only × bacterial inoculation) and (berseem-only × no bacterial inoculation) in the second harvest recorded the highest mean nitrogen concentration in the plant at 0.77% for both treatments. Additionally, the (berseem-only × bacterial inoculation) combination achieved the highest plant height in the fourth harvest at 68.90 cm. The (50% barley + berseem × bacterial inoculation) combination in the fourth harvest recorded the highest mean number of branches per square meter at 3,840 branches m⁻², furthermore, the (barley-only × bacterial inoculation) combination in the fourth harvest recorded the highest fresh forage yield at 99.70 tons ha⁻¹. Additionally, the (100% barley + berseem × bacterial inoculation) combination in the second harvest recorded the highest dry forage yield at 11.88 tons ha⁻¹.

Introduction

Mixing forage seeds (Grass – Legume mixture) is considered the best practice for producing forage mixtures due to its advantages over monoculture systems. Legumes have the ability to fix atmospheric nitrogen and maintain soil fertility through symbiosis with *Rhizobium* spp. bacteria, in addition to producing a high yield of dry matter with high carbohydrate content. Compared to cereal grains with high protein content, legume–cereal mixtures result in superior benefits, as they provide high-quality forage with balanced nutritional value (Balabanah et al., 2010). Furthermore, seed mixtures help improve soil fertility, enhance weed resistance, promote crop growth, and increase water and nutrient absorption efficiency since seed mixtures are considered low-cost technology for producing sustainable crops in low-income farming systems, they may achieve higher yields due to the variation in their components, better recycling and utilization of nutrients lost from the soil, and better control of pests and weeds (Ahmed et al., 2012). Mixing two or more crops is better than monoculture, as the resulting mixture gives higher yields due to structural, morphological, and functional diversity, which leads to beneficial interactions among them, on one side, and with the environment, on the other (Atis et al., 2012).

Egyptian clover (*Trifolium alexandrinum* L.) is one of the most important legume forage crops grown in regions with moderate winter climates, including Iraq. Egyptian clover is considered a complete fodder for livestock due to its high content of crude protein, carotene, phosphorus, and calcium, which makes it suitable for all types of livestock, whether for green fodder, hay, or silage. This gives Egyptian clover great importance (Tawfiq et al., 1992), in addition to its ability to grow rapidly and produce high-quality, nutritious forage. It can be cut several times during the season, ranging between 4–5 cuts, and gives a green fodder yield ranging between 40–60 tons/ha (Al-Maioof, 1982).

Materials and Methods

The experiment was conducted at the Second Agricultural Research and Experiment Station, College of Agriculture, Al-Muthanna

University, located in Al-Bandar village, southwest of Al-Muthanna Governorate, during the winter growing season of 2023–2024. The study involved two factors:

1. Bacterial inoculation: inoculated and non-inoculated.
2. Seed mixture ratios: four ratios of barley seeds were tested (100%, 75%, 50%, and 25% of the recommended seeding rate of 120 kg ha⁻¹ for the local barley cultivar), mixed with a constant rate of 40 kg ha⁻¹ of the alfalfa cultivar (Masaqawi).

The experiment was laid out in a split-plot design using a randomized complete block design (RCBD) with two factors. The main plots were assigned to the bacterial inoculation treatments, while the subplots were assigned to the four seed mixture ratios along with two control treatments (alfalfa only and barley only). Each treatment was replicated three times, giving a total of 3 experimental units, the experimental land was ploughed twice in perpendicular directions using a moldboard plough, then disk harrowed and leveled with a leveling machine. Plots were prepared according to the design, each measuring 2 × 2 = 4 m². Barley and alfalfa seeds were sown by broadcasting on October 21, 10, 2023 and then covered with soil, the inoculum was prepared in the Plant Protection Department laboratories, where the bacterial culture was propagated and loaded onto peat moss. The inoculum was mixed with alfalfa seeds using Arabic gum as an adhesive. The plants were manually harvested at a height of 10 cm above soil level, when alfalfa plants in the control treatment reached a height of 40 cm at each cutting, (Abdel Raouf et al.) (1967).

Studied Traits

Nitrogen concentration (%) was calculated according to the method of Cresser and Parsons (1979).

Plant height (cm): Plant height was measured in centimeters from the soil surface to the top of the plant using a measuring ruler, and five plants were taken randomly from each experimental unit and for all replicates, number of branches (branch/m²): The number of branches was counted within an area of one square meter for each experimental unit and for all replicates, green forage yield (ton·ha⁻¹): The green forage yield per experimental unit

was estimated by harvesting an area of ($25 \times 25 \text{ cm}^2$) randomly from each plot, and the fresh weight of the green forage was measured immediately using an electronic balance to avoid moisture loss. The average green forage yield per square meter ($\text{kg}\cdot\text{m}^{-2}$) was calculated and converted to $\text{ton}\cdot\text{ha}^{-1}$, dry forage yield ($\text{ton}\cdot\text{ha}^{-1}$): The dry forage yield was calculated based on conducting the air-drying process until a constant weight was reached for the green forage yield, then converted from $\text{kg}\cdot\text{m}^{-2}$ to $\text{ton}\cdot\text{ha}^{-1}$.

Statistical Analysis

The obtained data were analyzed statistically using the GENSTAT program according to the Data Analysis tool, and the means of the treatments were compared using the Least Significant Difference (LSD) test at a 0.05 probability level.

Title: Concentration and Pollination (or Fertilization)

Subtitle: Nitrogen Concentration (%)

The results in Table (1) indicated that the pollen granule treatment significantly surpassed the treatment without bacterial inoculation in Nitrogen concentration in the second and fourth cuts, with their averages reaching 0.70% and 0.76%, respectively. The reason for the increase in Nitrogen content in the vegetative growth when treated with inoculation is attributed to the efficiency of the added bacterial inoculation, which led to an increase in the number of Rhizobia bacteria and/or an increase in the number of root nodules, and an increase in their ability to fix nitrogen biologically and/or increase its uptake by the plant, and its concentration in the vegetative growth. This finding agreed with (Provorav, 1998), Al-Saadi (2001), and (nony, 2012).

The results showed that the treatments of clover and (vetch pollen) only significantly surpassed the mix ratio treatments (clover +barley) for the second cut, with their averages reaching 0.97% and 0.77%, respectively. Meanwhile, the barley-only treatment significantly surpassed all other treatments in the third cut, recording the highest average of 0.98%. As for the fourth cut, the treatment (25% barley + clover) gave the highest average of 0.55% and significantly surpassed all other treatments. This may be attributed to the optimal distribution of elements, which led to a reduction in competition between plants in the unit area, which in turn led to an increase in

nitrogen absorption and its concentration in the plant.

The results, considering the interaction between bacterial inoculation and mix ratios across all cuts, showed that the combination (50% barley + clover X bacterial inoculation treatment) gave the highest average in the first cut, reaching 0.53%, compared to the lowest average recorded by the combination (100% barley + clover X treatment without bacterial inoculation), which was 0.31%. Similarly, the combination (clover only X bacterial inoculation treatment) and (clover only X treatment without bacterial inoculation) recorded the highest average in the second cut, reaching 0.77% for both combinations, compared to the lowest average recorded by the combination (clover only X bacterial inoculation (25% barley + clover X treatment without bacterial inoculation)), which was 0.36% for both combinations. Meanwhile, the combination (barley only X bacterial inoculation treatment) ranked highest in the third cut, recording an average of 0.64% and significantly differing from the rest of the combinations. The combination (25% barley + clover X treatment without bacterial inoculation) recorded the highest average in the fourth cut, reaching 0.59% and significantly differing from the rest of the combinations, except for the combination (100% barley + clover X bacterial inoculation treatment), from which it did not significantly differ with an average of 0.53%.

Plant Height (cm)

The results in Table (2) showed that the bacterial inoculation treatment significantly surpassed the non-inoculation treatments in terms of plant height for the third and fourth cuts, with their averages reaching 49.44 cm and 62.40 cm, respectively, compared to the averages of the non-inoculation treatments, which were 41.69 cm and 55.90 cm, respectively.

This may be due to the nitrogen resulting from the biological fixation process carried out by the bacteria, which leads to optimal vegetative growth, an increase in cell size, and rapid cell division, in addition to raising the efficiency of photosynthesis and nutrient synthesis. This, in turn, leads to an increase in the number of internodes on the stem or an increase in internode length, or both, during vegetative growth, which positively reflects on the

increase in plant height. This finding is consistent with Al-Tamimi (1998), who indicated that adding bacterial inoculation increases the amount of readily available nitrogen for the plant, thus improving nitrogen absorption efficiency. This results in the optimal utilization of nitrogen through the formation of proteins and other important compounds, and consequently, an increase in plant height. These results also align with the findings of Hassan (2004) & Al-Fredan (2008), Abd et al. (2009), Naama (2011), Al-Burki (2013), Al-Hasinawi (2016), and Al-Husnawi (2017), all of whom concluded that plant height was higher in inoculation treatments compared to non-inoculation treatments.

The results show that the clover-only treatment significantly surpassed the mix ratio treatments (clover + barley) in plant height for the third and fourth cuts, with their averages reaching 49.93 cm and 68.70 cm, respectively. Meanwhile, the treatment (75% barley + clover) gave the highest average in the second cut, reaching 44.50 cm, compared to the lowest average recorded by the treatment (25% barley + clover), which was 34.80 cm. The treatment (100% barley + clover) significantly outperformed others in the fifth cut, where its average reached 61.40 cm, compared to the lowest average recorded by the treatment (50% barley + clover), which was 49.80 cm.

The superiority of the clover-only treatment in the third and fourth cuts may be attributed to the fact that sole cropping provided a better opportunity for growth, dry matter production, cell division, and elongation due to reduced competition resulting from the lower number of plants per unit area. This means more efficient absorption of water and nutrients, which subsequently leads to increased plant height rates. This is further confirmed by the superiority of the low mix ratios compared to the high mix ratios of barley with clover (plant quantity), as increasing the ratio of the blend will exacerbate the competition state in the early stages of growth, especially since Barley grows faster than clover, and this aligns with the decrease in temperature degrees during the winter season. This is consistent with Muhammad and Rana (2012), Rashid and Zaidan and Saleh (2010), and S.L. Awe and Abegunrin (2009). They all concluded that the height of inoculated plants was higher than the non-inoculated ones when compared to intercropping.

The increase in plant height in the third, fourth, and fifth cuts is attributed to the increase in plant density due to the increase in the number of seeds in the unit area, along with the increased efficiency of the plants in utilizing sunlight adequately. This result is consistent with what was reached by Abu Al-Utaibi (2000), Soleymani et al. (2011), and Al-Refay and Al-Ghulibi (2009) and Al-Aqili (2011) and Hashim and Ali (2012), who all reported that increasing seeding rates leads to an increase in plant height rates, the results showed a significant effect of the interaction between bacterial inoculation and mix ratio in the third and fourth cuts. The combination (clover only X bacterial inoculation treatment) and (clover only X treatment without bacterial inoculation) gave the highest averages for the trait, 52.40 cm and 68.90 cm for both cuts, respectively.

In the fourth cut, there was no significant difference between the combinations: (100% barley + clover X bacterial inoculation treatment) and (clover only X bacterial inoculation treatment), with their averages reaching 68.50 cm. Meanwhile, the combination (50% barley + clover X bacterial inoculation treatment) recorded the lowest average in the second cut, reaching 46.70 cm.

There was no significant difference between a number of combinations for the trait (plant height) in the fifth cut. The combination (100% barley + clover X bacterial inoculation treatment) gave the lowest average, 45.30 cm, while the combination (100% barley + clover X bacterial inoculation treatment) gave the highest average in the fifth cut, reaching 68.40 cm, compared to the lowest average recorded by the combination (50% barley + clover X treatment without bacterial inoculation), which was 46.30 cm.

Number of Tillers.m⁻²

The results of the analysis presented in Table (3) showed that the bacterial inoculation treatment significantly surpassed the non-inoculation treatments for the trait Number of Tillers for all cuts. Their averages reached 1037, 1357, 1366, 3083, and 1649 tillers.m⁻², respectively, compared to the averages of the non-inoculation treatments, which were 475, 901, 836, 1450, and 1271 tillers.m⁻², respectively. The reason for the increase in the number of tillers may be due to the increase in biological nitrogen fixation resulting from the increased number of root nodules on the plant, which leads to increased vegetative mass and

consequently an increase in the number of tillers. These results agreed with the findings of Saad (2011), nony (2012), and other researchers.

The results show that the clover-only treatment significantly surpassed all cuts in the number of tillers per plant, except for the first cut. Its averages reached 1397, 1552, 2900, and 1783 tillers.m⁻², respectively. Meanwhile, the mixed treatment (100% barley + clover) was superior in the first cut, with an average of 864 tillers.m⁻², compared to the lowest average of 583 tillers m⁻².

This superiority may be attributed to the massive growth of the clover plant, which assists the plants in the mixed treatment, allowing them to grow well and increase their tillering ability due to better nutrient uptake from the soil compared to treatments where the proportion of barley in the mixture was reduced. Conversely, it was also mentioned that a reduction in the barley mixture led to increased competition between plants and, consequently, a reduced ability to tiller. This finding is consistent with Sanderson and Elwinger (1999), Al-Zarkani (2007), and Al-Farjawi (2014), who indicated that sole cropping increased the number of tillers, and this number decreased in the mixed treatment, according to mixed farming with leguminous crops, the results regarding the interaction between bacterial inoculation and mix ratio across all cuts showed the following:

The combinations (clover only X bacterial inoculation treatment) and (clover only X treatment without bacterial inoculation) gave the highest average, reaching 1680, 2128 and 2053 tillers m⁻², respectively, significantly differing from the rest of the combinations, except for the (50% barley + clover X bacterial inoculation treatment) in the second cut, which had an average of 1600 tillers m⁻².

The combinations (50% barley + clover X bacterial inoculation treatment) and (100% barley + clover X bacterial inoculation treatment) in the fifth cut recorded averages of 1840 and 1680 tillers m⁻², respectively, in the first cut, the combination (100% barley + clover X bacterial inoculation treatment) gave the highest average number of tillers, reaching 1248 tillers m⁻², and significantly differed from all other combinations except for the two combinations (clover only X bacterial inoculation treatment) and (75% barley + clover X bacterial inoculation treatment),

whose averages reached 1205 and 965 tillers m⁻², respectively, the combination (75% barley + clover X treatment without bacterial inoculation) recorded the lowest average for the trait in the first cut, reaching 309 tillers m⁻². As for the fifth cut, the combination (50% barley + clover X bacterial inoculation treatment) gave the highest average number of tillers, reaching 3840 tillers m⁻², and significantly differed from all other combinations except for the combination (clover only X bacterial inoculation treatment), from which it did not significantly differ, with an average of 3760 tillers m⁻².

Meanwhile, the combination (75% barley + clover X treatment without bacterial inoculation) recorded the lowest average, reaching 987 tillers.m⁻². This may be attributed to the availability of nitrogen and seed rate are among the main factors determining the plant is branching capacity, their combined effect on this trait and the achievement of optimum results depend on maintaining a balance between them.

Green Fodder Yield (ton/ha⁻¹)

The results in Table (4) showed that the (75% barley + clover) treatment recorded the highest average in the first cut, reaching 28.10 ton/ha⁻¹, compared to the lowest average recorded by the barley-only treatment, which was 13.50 ton/ha⁻¹. The (100% barley + clover) treatment recorded the highest averages in the second and third cuts, reaching 66.70 and 86.60 ton/ha⁻¹, respectively. Meanwhile, the barley-only treatment gave the highest average in the fourth cut, reaching 77.70 ton/ha⁻¹, with no significant difference from several treatments, particularly the (50% barley + clover) treatment, which had an average of 71.40 ton/ha⁻¹. The clover-only treatment recorded the lowest average for the trait, reaching 29.20 ton/ha⁻¹.

The sharp increase in green fodder yield in the first cut may be attributed to the effect of the mixing ratios on the increased plant density resulting from sowing high amounts of seeds. This led to an increased number of plants in the fodder mixture per unit area, which positively reflected on the fodder yield. These results align with the findings of Karadag and Buyukturkc (2003), Dawla (2004), Al-Khateeb et al. (2006), Shoaib et al. (2013), and Ansar et al. (2012), who all obtained a significant increase in green fodder yield when seed quantities were increased.

The increase in seed quantity is primarily due to the increase in the number of barley seedlings per unit area. Its combined increase in height contributed to raising the fodder yield to the level of significant superiority of intercropping over sole cropping in the first, second, and third cuts. Furthermore, the magnitude of the increase in mixed crops compared to sole cropping treatments varied from cut to cut. This finding is consistent with Kwabiah (1996) and Taylor and Quesenberry (2005) in obtaining a significant increase in green fodder yield for intercropping at the expense of sole cropping when seed quantity was increased, the results indicated a significant difference for the interaction between bacterial inoculation and mix ratio across all cuts, the combination (75% barley + clover X bacterial inoculation treatment) gave the highest average in the first cut, reaching 31.70 ton/ha⁻¹, with no significant difference from several combinations, especially the (100% barley + clover X treatment without bacterial inoculation), which had an average of 26.80 ton/ha⁻¹, the combination (barley only X bacterial inoculation treatment) recorded the lowest average in the first cut, reaching 11.50 ton/ha⁻¹.

The combination (25% barley + clover mix X bacterial inoculation treatment) recorded the highest average in the second cut, reaching 90.40 ton/ha⁻¹, with no significant difference from several combinations, especially the (75% barley + clover mix X treatment without bacterial inoculation), which had an average of 88.50 ton/ha⁻¹, the combination (barley only X bacterial inoculation treatment) recorded the lowest average in the second cut, reaching 29.90 ton/ha⁻¹.

In the third cut, the combination (100% barley + clover X bacterial inoculation treatment) recorded the highest average, reaching 69.30 ton/ha⁻¹, with no significant difference from several combinations, especially the (100% barley + clover X treatment without bacterial inoculation), which had an average of 64.00

Dry Forage Yield (t ha⁻¹)

The results presented in Table (5) show that the mixture treatment (75% clover+ 25% barley) in the first harvest recorded the highest mean dry forage yield, reaching 3.14 ton/ha⁻¹, without a significant difference from a number of treatments, particularly the treatment (50% clover + 50% barley), which recorded a mean

ton/ha⁻¹, the combination (barley only X bacterial inoculation treatment) recorded the lowest average in the third cut, reaching 35.70 ton/ha⁻¹, the combination (barley only X bacterial inoculation treatment) gave the highest average in the fourth cut, reaching 99.70 ton/ha⁻¹, and significantly differed from all other combinations, discussion on Superiority the superiority of the treatments involving bacterial inoculation and mixing ratios across all cuts can be attributed to the increase in the number of plants due to the effect of seed quantities, and the crucial role of inoculation in nitrogen formation. This leads to increased growth and plays a role in many vital activities, transforming nitrogen into several plant components such as amino acids, nucleic acids, and energy compounds, in addition to supporting symbiotic life (like mycorrhizae and green bacteria) in the tillers (Abu Dhahi and Younis, 1988 ;Oaks, 1994; Hopkins, 1999). This is besides its role in promoting cell division, expansion, and elongation, which means the formation of a balanced shoot and root system capable of utilizing production factors (nutrients and light) better, as noted by Mohr et al. (2013), Meral et al. (2015), Salama and Badry (2004). This leads to the synthesis and accumulation of dry matter in the components of the fodder mixture, which reflected on the increase in the green fodder yield of the mixture, The minor differences in results between the cuts can be interpreted as small, relative variations. The important takeaway is that the results of the cuts showed the superiority of mixed treatments over sole cropping treatments in the first, second, and third cuts. Furthermore, the inputs of intercropping barley with clover as a fodder mixture yield positive and economically viable results at the expense of green fodder sole cropping, and thus increase the production objectives per unit area, this result is in agreement with the findings of Al-Mandlawi (2017) in his study on the mixture (clover + barley).

of 3.08 ton/ha⁻¹, In contrast, the barley-only treatment gave the lowest mean value for this trait, amounting to 1.24 ton/ha⁻¹, In the second and third harvests, the treatment (100% clover + barley) recorded the highest mean values of 10.26 and 8.59 ton/ha⁻¹, respectively, with significant differences compared to all other treatments, except for the treatment (75% clover + 25% barley), which did not differ

significantly from it, recording mean values of 9.55 and 8.03 ton/ha⁻¹, for both harvests, respectively, in the fourth harvest, the barley-only treatment recorded the highest mean for this trait, reaching 11.35 ton/ha⁻¹, with significant differences from all mixture ratio treatments (clover + barley), except for the treatment (100% clover + barley), which did not differ significantly and recorded a mean of 8.49 ton/ha⁻¹. This may be attributed to the interpretations mentioned regarding green forage yield, which was positively affected by increasing dry matter yield in forage mixtures (Table 4). These results are consistent with the findings of Al-Khateeb et al. (2006), Al-Zarkani (2007), Ansar et al. (2012), Shoaib et al. (2014), and Al-Mandalawi (2017).

The results also showed a significant interaction effect between bacterial inoculation and mixture ratios in all harvests. The combination treatment (50% clover + barley × bacterial inoculation) recorded the highest mean dry forage yield in the first harvest, reaching 3.36 ton/ha⁻¹, with significant superiority over all other combinations except the two combinations (75% clover + barley × bacterial inoculation) and (25% clover + barley without bacterial inoculation), which did not differ significantly, recording mean values of 3.30 and 3.29 ton/ha⁻¹, respectively. The combination (100% clover + barley × bacterial

inoculation) recorded the highest mean values in the second and third harvests, reaching 11.88 and 8.97 ton/ha⁻¹, respectively, without significant differences compared to several other combinations, particularly (75% clover + barley × without bacterial inoculation) and (25% clover + barley × bacterial inoculation), which recorded mean values of 11.67 and 8.25 ton/ha⁻¹, respectively, for the two harvests. Meanwhile, the combinations (barley only × bacterial inoculation) and (barley only without bacterial inoculation) recorded the lowest mean values of 3.43 and 3.83 ton/ha⁻¹, for both harvests, respectively. In the fourth harvest, the combination (barley only × bacterial inoculation) gave the highest mean of 11.73 ton/ha⁻¹, with a significant difference from several other combinations, whereas the combination (25% clover + barley × without bacterial inoculation) recorded a mean of 10.96 ton/ha⁻¹. The lowest mean for this trait was recorded by the combination (75% clover + barley × bacterial inoculation), reaching 3.62 ton/ha⁻¹. The superiority of bacterial inoculation treatments and higher mixture ratios in increasing dry forage yield may be attributed to their original superiority in green forage yield of forage mixtures (Table 4), which was positively reflected in dry forage yield (Table 5).

Table(1) Effect of bacterial inoculation mixing ratios and their interaction on nitrogen concentration.

Second cutting				First cutting			
average	un inoculated	inoculated	bacterial inoculant mixing ratios	average	un inoculated	inoculated	bacterial inoculant Mixing ratios
0.77	0.77	0.77	Clover only	0.36	0.36	0.36	Clover only
0.97	0.57	0.36	Barley only	0.43	0.50	0.37	Barley only
0.38	0.36	0.40	barley %25 clover+	0.44	0.44	0.45	%25 clover+barley
0.58	0.57	0.59	barley %50 clover+	0.44	0.35	0.53	%50 clover+barley
0.55	0.48	0.62	barley %75 clover+	0.36	0.35	0.38	%75 clover+barley
0.43	0.40	0.47	+barley%100 clover	0.33	0.31	0.36	%100 clover+barley
	0.52	0.70	average		0.38	0.41	Average
interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interaction	mixing ratios	bacterial vaccine	L.S.D value (0.05)

0.38	0.27	0.15		0.20	N.S	N.S	
Fourth cutting				Third cutting			
average	un inoculated	inoculated	Bacterial inoculant mixing ratios	average	un inoculated	inoculated	Bacterial inoculant mixing ratios
0.27	0.27	0.27	Clover only	0.36	0.36	0.36	Clover only
0.45	0.47	0.44	Barley only	0.58	0.52	0.64	Barley only
0.55	0.59	0.51	barley %25 clover+	0.38	0.33	0.44	%25 clover+barley
0.41	0.38	0.44	barley %50 clover+	0.45	0.45	0.45	%50 clover+barley
0.46	0.41	0.51	barley %75 clover+	0.45	0.43	0.47	%75 clover+barley
0.48	0.44	0.53	+barley%100 clover	0.44	0.39	0.49	+barley%100 clover
	0.43	0.45	average		0.41	0.47	average
interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)
0.06	0.04	0.02		0.05	0.03	N.S	

Table(2) Effect of bacterial inoculation mixing ratios and their interaction on plant height (cm) of Alfalfa.

Second cutting				First cutting			
average	un inoculated	inoculated	Bacterial inoculant mixing ratios	average	un inoculated	inoculated	Bacterial inoculant mixing ratios
39.70	40.00	39.50	Clover only	28.37	29.07	27.67	Clover only
34.80	32.30	37.30	+ barley %25 clover	29.63	25.73	33.53	clover+barley %25
39.20	31.70	46.70	+ barley %50 clover	29.23	26.00	32.47	clover+barley %50
44.50	45.30	43.70	+ barley %75 clover	30.37	32.20	28.53	clover+barley %75
43.40	41.50	45.30	%100 clover+barley	29.80	30.07	29.53	clover+barley%100
	38.20	42.50	average		28.61	30.35	average
interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)
11.21	7.93	N.S		N.S	N.S	N.S	
Fourth cutting				Third cutting			
average	un inoculated	inoculated	Bacterial inoculant mixing ratios	average	un inoculated	inoculated	Bacterial inoculant mixing ratios
68.70	68.90	68.50	Clover only	49.93	47.47	52.40	Clover only
53.40	48.70	58.10	+ barley %25	41.77	37.07	46.47	clover+barley %25

			clover				
55.30	49.50	61.10	+ barley %50 clover	44.63	37.87	51.40	clover+barley %50
58.70	55.60	61.70	+ barley %75 clover	47.10	46.47	47.73	clover+barley %75
59.70	57.00	62.50	%100 clover+barley	44.40	39.60	49.20	clover+barley%100
	55.90	62.40	average		41.69	49.44	average
interacti on	mixing ratios	bacterial inoculan t	L.S.D value (0.05)	interact ion	mixing ratios	bacterial inoculant	L.S.D value (0.05)
12.57	8.89	5.62		7.59	5.36	3.39	
Fifth cutting							
	average	un inoculate d	inoculated	Bacterial inoculant mixing ratios			
	60.10	59.80	60.50	Clover only			
	50.00	48.60	51.40	clover+barley %25			
	49.80	46.30	53.40	clover+barley %50			
	53.10	51.00	55.20	clover+barley %75			
	61.40	54.30	68.40	clover+barley%100			
		52.00	57.80	average			
	interact ion	mixing ratios	bacterial inoculant	L.S.D value (0.05)			
	15.06	10.65	N.S				

Table(3) Effect of bacterial inoculation mixing ratios and their interaction on the number of branches (m⁻¹) in alfalfa.

Second cutting				First cutting			
average	un inoculate d	inoculat ed	bacterial inoculant mixing ratios	averag e	un inoculated	inoculate d	Bacterial inoculant mixing ratios
1397	1115	1680	Clover only	847	488	1205	Clover only
901	640	1163	+ barley %25 clover	583	309	856	%25 clover+barley
1279	957	1600	+ barley %50 clover	736	560	912	%50 clover+barley
1019	736	1301	+ barley %75 clover	751	536	965	%75 clover+barley
1048	1056	1040	%100 clover+barley	864	480	1248	+barley%100 clover
	901	1357	average		475	1037	average
interactio n	mixing ratios	bacteria l inocula nt	L.S.D value (0.05)	interac tion	mixing ratios	bacterial inoculant	L.S.D value (0.05)
609.7	431.1	272.7		319.4	225.8	142.8	

Fourth cutting				Third cutting			
average	un inoculated	inoculated	Bacterial inoculant mixing ratios	average	un inoculated	inoculated	bacterial inoculant mixing ratios
2900	2040	3760	Clover only	1552	976	2128	Clover only
2080	1520	2640	+ barley %25 clover	893	699	1088	%25 clover+barley
2560	1280	3840	+ barley %50 clover	1107	800	1413	%50 clover+barley
1893	987	2800	+ barley %75 clover	867	693	1040	%75 clover+barley
1899	1424	2373	%100 clover+barley	1087	1013	1160	+barley%100 clover
	1450	3083	average		836	1366	average
interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)
577.1	408.1	258.1		377.4	266.9	168.8	
				Fifth cutting			
average	un inoculated	inoculated	Bacterial inoculant mixing ratios	average	un inoculated	inoculated	Bacterial inoculant mixing ratios
1783	1513	2053	Clover only				
1139	1024	1253	%25 clover+barley				
1620	1400	1840	%50 clover+barley				
1228	1040	1416	%75 clover+barley				
1528	1375	1680	+barley%100 clover				
	1271	1649	average				
interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)
601.2	425.1	268.9					

Table(4) Effect of bacterial inoculation mixing ratios and their interaction on green forage yield (ton.ha⁻¹).

Second cutting				First cutting			
average	un inoculated	inoculated	bacterial inoculant mixing ratios	average	un inoculated	inoculated	Bacterial inoculant mixing ratios
44.30	44.30	44.30	Clover only	18.40	18.40	18.40	Clover only
31.20	32.50	29.90	Barley only	13.50	15.60	11.50	Barley only
73.40	56.40	90.40	barley %25 clover +	25.20	26.10	24.30	clover+barley%25

73.50	83.20	63.70	barley %50 clover +	23.20	26.40	20.00	clover+barley%50
75.90	88.50	63.20	barley %75 clover +	28.10	24.50	31.70	barley %75 clover+
86.60	86.00	87.20	%100 +barley clover	24.30	26.80	21.90	+barley%100 clover
	65.20	63.10	average		23.00	21.30	average
interactio n	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interactio n	mixing ratios	bacterial inoculant	L.S.D value (0.05)
19.48	13.78	N.S		10.52	7.44	N.S	
Fourth cutting				Third cutting			
average	un inoculate d	inoculate d	bacterial inoculant mixing ratios	average	un inoculate d	inoculate d	bacterial inoculant mixing ratios
29.20	29.20	29.20	Clover only	49.60	49.60	49.60	Clover only
77.70	55.60	99.70	Barley only	37.50	39.20	35.70	Barley only
63.10	73.20	53.10	barley %25 clover +	52.40	48.50	56.30	barley %25 clover+
71.40	75.60	67.20	barley %50 clover +	54.50	52.50	56.50	barley %50 clover+
55.60	43.20	68.00	barley %75 clover +	60.40	57.30	63.50	barley %75 clover+
67.60	74.90	60.30	%100 +barley clover	66.70	64.00	69.30	+barley%100 clover
	58.60	62.90	average		51.90	55.20	average
interactio n	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interactio n	mixing ratios	bacterial inoculant	L.S.D value (0.05)
18.03	12.75	N.S		22.84	16.15	N.S	

Table(5) Effect of bacterial inoculation mixing ratios and their interaction on dry forage yield (ton.ha⁻¹).

Second cutting				First cutting			
average	un inoculate d	inoculate d	bacterial inoculant mixing ratios	average	un inoculate d	inoculate d	bacterial inoculant mixing ratios
6.31	6.31	6.31	Clover only	2.56	2.56	2.56	Clover only
3.52	3.61	3.43	Barley only	1.24	1.50	0.99	Barley only
7.66	8.01	7.31	barley %25 clover+	2.95	3.29	2.61	clover+barley%25
8.21	9.54	6.88	barley %50 clover+	3.08	2.80	3.36	clover+barley%50
9.55	11.67	7.43	barley %75 clover+	3.14	2.98	3.30	barley %75 clover+
10.26	8.64	11.88	+barley%100 clover	2.90	2.88	2.92	+barley%100 clover
	7.96	7.21	average		2.67	2.62	average
interactio	mixing	bacterial	L.S.D value	interactio	mixing	bacterial	L.S.D value

n	ratios	inoculant	(0.05)	n	ratios	inoculant	(0.05)
2.63	1.85	N.S		0.66	0.46	N.S	
Fourth cutting				Third cutting			
average	un inoculated	inoculated	bacterial inoculant mixing ratios	average	un inoculated	inoculated	bacterial inoculant mixing ratios
4.30	4.30	4.30	Clover only	7.28	7.28	7.28	Clover only
11.35	10.96	11.73	Barley only	3.98	4.13	3.83	Barley only
3.70	3.79	3.62	barley %25 clover+	7.28	6.30	8.25	barley %25 clover+
6.17	7.09	5.24	barley %50 clover+	6.71	6.07	7.35	barley %50 clover+
6.77	4.51	9.03	barley %75 clover+	8.03	7.64	8.42	barley %75 clover+
8.49	9.87	7.11	+barley%100 clover	8.59	8.21	8.97	+barley%100 clover
	6.75	6.84	average		6.61	7.35	average
interaction	mixing ratios	bacterial inoculant	L.S.D value (0.05)	interaction	mixing ratios	bacterial inoculant	value L.S.D (0.05)
3.71	2.62	N.S		2.63	1.86	N.S	

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