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ESTIMATION OF QUANTITATIVE AND QUALITATIVE LOSSES DUE TO MAJOR PESTS OF LUCERNE

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SUMMARY

Studies on avoidable losses due to aphids based on quantitative and qualitative traits and those inflicted by *Spodoptera litura and Helicoverpa armigera* based on quantitative traits were undertaken on lucerne crop during 2013-14. Green forage yield losses in lucerne up to 29.87 per cent due to aphids, 42.28 per cent due to *S. lituara* and seed yield losses upto 41.01 per cent due to *H. armigera* were noticed. However, results of influence of aphids on quality parameter of lucerne showed drastic reduction in chlorophyll, dry matter, crude fibre, phosphorous, potassium, ash and calcium and increase in sugar content.

Keywords : Aphids, predators, *Chrysopa, Helicoverpa armigera, Spodoptera litura*

Lucerne (*Medicago sativa* L.), is a most important cosmopolitan forage crop, so it is called 'Queen' of forage crops. It is originated in Asia and was first observed to be cultivated in Iran before 700 BC. The term lucerne probably becomes associated with introductions from the Lucerne Lake region of Switzerland or from the Lucerne River Valley of Italy (Summer *et al.*, 2004). Lucerne has the highest feeding value among all commonly grown hay crops. It is consumed by most herbivores and omnivores, including all classes of livestock and big game animals. It is valued for rehabilitation of overgrazed ranges in part because it begins growth early and remains green succulent later than grasses. Due to its herbaceous nature and favorable temperature and humidity, the pests have enormous scope to perpetuate and build up their population on it. Lucerne suffers damage both qualitatively and quantitatively by aphids (*Acyrthiosiphon pisum* Harris, *Acyrthiosiphon kondoi* Shinjii and *Therioaphis trifolii* F. Although the impact of aphids on lucerne productivity may be influenced by a wide range of factors under CO_2 and evaporation transpiration, the effectiveness of natural enemies in controlling lucerne aphids will be a major influence (Thomson *et al*., 2010). These aphids are responsible to reduce yield and also palatability of lucerne fodder to livestock due to the secondary growth of black sooty mould. In the present studies estimation of losses and economic threshold level (ETL) for *A. pisum* was carried out. ETL for *A. pisum* was calculated to be 85 aphids/stem (Kulkarni, 2016). The quantitative losses recorded in India are about 37.7 % due to insect pests in lucerne (Alate, 2012). In India insect pests associated with this crop are spotted aphids, blue green aphid, pea aphid, leaf hopper, lucerne weevil, alfalfa caterpillar, tobacco caterpillar, semilooper, galerucid beetle, gray weevil, pentatomid bug, thrips, cut worms, *Helicoverpa armigera* and termites (Pal, 2014). However, in India information on such important aspect of the forage crops has lagged behind compared to other arable crops.

MATERIALS AND METHODS

Experiments were conducted on the farm of MPKV, Rahuri, Maharashtra and IGFRI Jhansi during the year 2013-14 on perennial lucerne variety RL-88. To estimate the losses due to aphids, *Spodoptera litura* and *Helicoverpa armigera,* experiments were laid out in paired plot design as suggested by Leclerg (1971). There were only two treatments *viz.,* protected and unprotected, replicated 12 times for each pest. The size of plot was 4 x 3 m^2 row to row spacing was 30 cm. Recommended agronomic practices including fertilizer doses and intercultural operations were adopted. The protected plots were kept free from pests infestation by spraying of imidacloprid @ 0.004 per cent for aphids, Spark 36 per cent EC @ 1000 ml/ha (Combination of deltamethrin 1 % and triazophos

35%) and *Sl*NPV 250 LE/ha for *S. litura* and spinosad 45 per cent SC @ 125 ml /ha and deltamethrin 0.0075per cent + *Ha*NPV 250 LE/ha alternately at 10 days interval throughout the crop stage for *H. armigera* to treated plots. The unprotected plots were exposed to natural infestation of pests. Finally at the time of cutting of lucerne for green forage, population of aphids per tiller and average number of larvae of *S. litura* was recorded from each replication of protected and unprotected plots. However, average number of larvae of *H. armigera* and seed yield was recorded in lucerne seed plot from each replication of protected and unprotected plots. The losses in yield due to aphids, *S. litura* and *H. armigera* were calculated by comparing the yields from chemically protected pest free plots with that in untreated plots damaged by pests and finally per cent losses were worked out.

For the estimation of qualitative losses due to aphids in lucerne, two blocks each with 6 replications with plot size 3 x 4 m^2 of each were selected. During severe damage, same aged plant samples were brought into laboratory from damaged and healthy plots for chemical analysis. Before collecting samples, replication wise aphid count was taken from both the blocks. Chlorophyll content was estimated from samples of fresh leaves of infested as well as healthy plants (Richardson *et al*., 2002). Nitrogen, phosphorous, potassium, crude protein, crude fiber, per cent ash, per cent dry matters content, calcium, magnesium and sugar content were worked out from the dry powder of samples using standard approved methods in laboratory (Kelley *et al.*, 1946; Bama 2016). The significance of the differences in data thus obtained was evaluated using 't' test.

RESULTS AND DISCUSSION

The lucerne quality and quantity suffered from three species of aphids viz., *Acyrthosiphon pisum* Harris, *Therioaphis maculata,* Buckton and *Aphis craccivora* Koch and two lepidopteran pests *viz., S. litura* and *H. armigera*. Among these, aphids and *S. litura* affected the green forage yield while, *H. armigera* caused damage to flowers and pods of lucerne seed crop. Aphids also affected the quality of green forage of lucerne due to their infestation. The data pertaining to quantitative losses due to aphids, *S. litura* and *H. armigera* on lucerne crop are presented in table 1 to 3 while qualitative losses due to aphids are presented in table 4 and 5.

TABLE 1
Losses of green forage yield due to aphids in lucerne crop

Treatment	Average No. of aphids/tiller	Av. green forage yield (q/ha)	Per cent loss in green forage yield
Protected	0.825	86.44	29.87
Unprotected	151.50	60.62	
' t ' cal.	14.40	12.28	

t ' table at 0.05-2.201 and 0.01-3.106.

TABLE 2
Losses of green forage yield due to *S. litura* in lucerne crop

Treatment	Average No. of *S. litura* larvae/ m^2	Av. green forage yield (q/ha)	Per cent loss in green forage yield
Protected	0.2	103.00	42.28
Unprotected	6.99	59.46	
' t ' cal.	16.69	10.99	

't ' table at 0.05-2.201 and 0.01-3.106.

TABLE 3
Losses of seed yield due to *H. armigera* in lucerne seed crop

Treatment	Average No. of H. armigera larvae/m^2	Av. GFY or seed (q/ha)	Per cent loss in seed yield of lucerne
Protected	0.1	4.868	41.01
Unprotected	6.72	2.872	
' t ' cal.	21.69	18.28	

' t ' table at 0.05-2.201 and 0.01-3.106.

Quantitative losses due to the pests

Aphids

The relative data on green forage yield revealed that the aphids were responsible for reducing the green forage yield considerably. In unprotected plot, average number of aphids/tiller was 151.50 as compared to 0.83 aphids/tiller in protected plot. There were significant difference in green forage yield of the protected (86.44 q/ha) and unprotected plots (60.62

TABLE 4
Influence of aphid infestation on chemical constituents of lucerne

Treatment	Av. No. of aphids/tiller	Chlorophyll content/mg/g			Dry matter (%)	Crude protein content (%)	Fibre (%)	Sugar mg/100
		a	b	Total				
1. Protected	0	0.357	0.698	0.344	24.79	17.35	24.73	75.40
2. Unprotected	148.35	0.212	0.397	0.188	21.28	16.48	19.03	102.50
		(40.55)*	(43.14)	(45.33)	(14.14)	(5.04)	(23.05)	(+35.94)
' t' cal.		4.00	31.82	4.69	4.44	5.89	9.85	8.61

*Per cent reduction and increase of chemical constitutes in unprotected treatments.

TABLE 5
Influence of aphids on mineral matters of lucerne

Treatment	Av. No. of aphids/tilelr	Nutrients			Ash (%)	Ca (mg/g)	Mg (mg/g)
		N (%)	P (%)	K (%)			
1. Protected	0	2.78	0.85	2.35	3.25	89.17	102.50
2. Unprotected	148.35	2.64	0.59	1.20	2.87	75.83	101.67
		(5.04)*	(30.22)	(48.93)	(11.79)	(14.95)	(0.82)
' t' cal.		5.92	5.88	20.49	40.16	1.66	0.06

*Per cent reduction of mineral matters in unprotected treatments.

q/ha). Consequently, the actual avoidable quantitative loss calculated was 29.87 per cent. Kindler *et al.* (1971) reported 28 per cent yield loss in dry matter due to aphids in lucerne. Harper and Freyman (1984) reported that pea aphid infestation reduced cold hardiness by 30-21 per cent, mean height by 28-32 per cent, tallest stem height by 29-31 per cent and top weight by 25-31 per cent in field trial. Quinsenberry *et al.* (1987) reported 43 per cent reduction in green forage yield of lucerne due to pea aphid when their population was 90 individuals /stem, respectively. The losses in green forage and seed yield of lucerne due to aphid reported by Patel *et al.* (2003). The present findings of reduction in green forage yield due to aphid are in agreement with the findings of those earlier workers with little variation due to climatic fluctuations prevailed at experimental location.

Spodoptera litura

It is observed from the table 2 that, average green forage yield recorded in protected plot was 103.00 q/ha , which was significantly higher than unprotected plot (59.46 q/ha), when average larval population was 0.2 larva/m^2 and 6.99 larvae/m^2 in protected and unprotected plots, respectively. The avoidable loss in green forage due to *S. litura* calculated on the basis of difference in green forage yield obtained from protected and unprotected plots were 42.28 per cent. Pal (2014) reported 50 per cent green forage yield of lucerne due to severe incidence of lepidopteron pests. The quantitative losses recorded in India were about 30 per cent due to insect pests in lucerne (Kulkarni 2016). The present results are in corroboration with the above research workers in respect of quantitative losses of lucerne.

Helicoverpa armigera

Data presented in table 3 showed significantly higher seed yield of lucerne in protected plot (4.87 q/ha) than unprotected one (2.87 q/ha). The significantly lowest average number of larval population of *H. armigera* was recorded in protected plot (0.1 larva/m^2) than unprotected plot (6.72 larvae/m^2). The recorded average avoidable seed yield loss due to *H. armigera* was 41.01 per cent in lucerne. Patel *et al.* (2003) observed seed yield losses in lucerne up to 16.49 per cent could be avoided by chemical spray of endosulfan (0.05 %) at flowering stage. Therefore, the control of *H. armigera* at flowering stage could avoid losses in lucerne.

Qualitative losses due to aphids

Chlorophyll

Chlorophyll is plant pigment which imparts a green colour to plant. In presence of sunlight this pigment is necessary to convert the radiant energy to chemical energy. The aphid population per tiller of lucerne was 148.35. The chlorophyll a, b and total chlorophyll content of lucerne leaves were 0.212, 0.397 and 0.188 mg/g fresh weight of tissue, respectively. Numerically these values are reduced to fifty per cent to that of healthy plot 0.357, 0.698 and 0.344 mg g^{-1} fresh weight of tissue, respectively. The magnitude of reduction was to the extent of 40.55, 43.14 and 45.33 per cent. The rate of reduction in chlorophyll content was more in total chlorophyll followed by chlorophyll-b and chlorophyll-a. The degradation of chlorophyll might be associated with sucking type habit of aphids disturb the plant tissue and cell with hindrance of photosynthetic activity due to development of black sooty mould on leaves as results of sugary excretion by the pest (Golan *et al.*, 2015). As result the plant is not able to synthesize chlorophyll.

Dry matter

The per cent dry matter of lucerne was decreased to 14.14 per cent due to aphid infestation (21.28 per cent) as compared to healthy plant (24.79 per cent). The reduced dry matter per cent was the result of reduction of the stem elongation rate, leaf and stem numbers, stem height, stem to leaf ratio and carbohydrates levels of roots (Girousse *et al.*, 1998). Harper and Freyman (1984) reported that pea aphid infestation reduced cold hardiness by 30-21 per cent, mean height by 28-32 per cent, tallest stem height by 29-31 per cent and top weight by 25-31 per cent in field trial.

Crude protein and Crude fibre

Crude protein content of lucerne plant was not varied by the infestation of aphid as compared to healthy plant; whereas, 23.05 per cent variation was observed in crude fibre content in aphid infested plant (19.03 per cent) than in healthy plant (24.73 per cent) (Ingawale and Tambe, 2007).

Sugars

The aphid infestation to lucerne considerably deteriorated the carbohydrate content of lucerne. The sugars content of aphid infested lucerne plant was 102.50 mg/ 100g whereas, it was 75.40 mg/ 100g protected plot. It was increased to the extent of 35.94 per cent. The increase in sugars content indicated that plant tissue injury caused by aphids oozed out the cell sap and insertion of saliva of aphid. The sizable honey dew like excretion by the pest on the leaves substantially contributed to the increased sugars content of the infested plants and increase soil nitrogen availability (Grier and Vogt, 1990). This may leads to formation of mould on surface plant parts. As result, inversion process of degrading carbohydrates to simple sugar. Therefore, sugars content in aphid infested plant is more than healthy plants of lucerne.

Mineral matters

The ash content of lucerne plant was reduced by 11.69 per cent due to aphid infestation over healthy plant. The least change was observed in nitrogen and magnesium followed by calcium. Drastic change was observed in case of potassium content of lucerne due to aphid infestation. It was in the tune of 48.93 per cent over healthy plant. Similarly, the phosphorus content was also decreased from 0.85 per cent to 0.59 per cent. The per cent decrease was 30.22 per cent. In general, the potassium and phosphorus loss in lucerne are more pronounced by the aphid infestation (Myers and Gratton, 2006). Whereas, other mineral matter were slightly changed. These observations indicated that the magnesium and calcium might be providing hardness to cell structure or in the form of pectic substances. Hence, they remain unchanged due to aphid infestation. The potassium and phosphorus ions are present in cell sap of plant cell. The injury caused by aphid to lucerne plant oozed out the cell sap, which consist of potassium and phosphorus. This might be the reason for reduction in potassium and phosphorus content of lucerne plant by the aphid infestation.

Few research workers carried out the work on influence of aphids on quality parameters. Kain *et al.* (1979) observed significant reduction in leaf and stem numbers, stem height, stem to leaf ratio and carbohydrates levels of roots. A reduction in plant density 18% was recorded in aphid damaged plots in

early winter. It was also reported that there was depression in crude fibre, increase in per cent carbohydrate, decreased level of carotene, xanthophylls and K in aphid damaged herbage. Narayanaswamy *et al.* (1999) reported that the content of moisture, chlorophyll a and b, crude protein, sugars, nitrogen, phosphorus, calcium and magnesium were drastically reduced in an infested leaves of mulberry. Xinzhi *et al.* (2001) found that aphid feeding caused significant losses of chlorophyll a and b and carotenoids in the damaged region of wheat leaves. Girousse *et al.* (1998) observed that stem elongation is one of the main processes contributing to shoot growth and yield in lucerne but due to infestation of pea aphids (200 apterous adults in pre-reproductive phase, located on the elongation zone 24 h) caused a reduction of the stem elongation rate up to 70%. This involved 42 per cent shortening the elongation zone as well as reducing the relative elemental growth rate by 60 per cent. The rates of dry matter assimilation were also lower in infested stem. In that way the present study are also related with the above research work in respect of qualitative losses of lucerne by aphid infestation.

CONCLUSION

The avoidable losses due to aphids, *S. litura* attacking lucerne foliage and *H. armigera* attacking seed were 29.87, 42.28 and 41.01 per cent in lucerne, respectively. The qualitative loss in chlorophyll-a, chlorophyll-b, total chlorophyll, dry matter, crude fibre, P, K, ash and Ca content were 40.55, 43.14, 45.33, 14.14, 23.05, 30.22, 48.93, 11.69 and 14.96 per cent, respectively. To avoid quantitative and qualitative losses, the management strategies should be adopted as and when pests infestation starts built up on crop.

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