



Varietal Response to Population Fluctuation of Insect Pests, Predators and Pollinator Fauna Associated with Berseem (*Trifolium alexandrinum* L) Crop

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ABSTRACT

Eleven varieties of berseem (*Trifolium alexandrinum*) in three replicates. Anmol berseem, Super berseem, agaiti berseem, pachaiti berseem, sandal berseem, Faisalabad 1, Faisalabad 2, P-94, Punjab berseem, Pakistani berseem and chenab berseem were used. Our results revealed that armyworm, *Spodoptera exigua*, aphid (*Sitobian avenae* L.) and leaf miner [*Aproaerema modicella*] are important pests of berseem while the coccinellids and a syrphid fly are important predators. Varieties viz., super berseem, pachaiti berseem, Faisalabad 2, P-94 and Punjab berseem proved comparatively resistant to armyworm attack, while varieties viz., anmol berseem, sandal berseem, Pakistani berseem and chenab berseem proved moderately resistant. Agaiti berseem proved highly susceptible to armyworm attack. Varieties viz., anmol berseem, agaiti berseem, Faisalabad 1, P-94, and chenab berseem proved resistant to aphid attack. Super berseem, pachaiti berseem and Punjab berseem proved moderately resistant. Sandal berseem was susceptible to aphid complex. Leaf miner dispersion on all varieties was non significant. Predators viz., dispersal of Coccinellidae was non-significant on all varieties while the syrphid fly was unevenly distributed on various varieties of berseem. *Apis mellifera* and adults of the syrphid fly proved to be important pollinator fauna for berseem.

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Authors' Contributions

AH designed the experiments, collected data and wrote the article. HK prepared figures and NM analyzed the data. RAK provided seeds for this study.

Key words

Berseem, armyworm, aphid, leaf miner, honey bee, syrphid, Coccinellid.

INTRODUCTION

Berseem (*Trifolium alexandrinum* L.) is an important leguminous forage crop in Pakistan (Karishnamurthi, 1959). It is highly nutritious, palatable (FAO, 2011) and a high-yielding fodder crop (Clark *et al.*, 1992) that is well adopted in Pakistan (Chaudhry *et al.*, 1991; Chaudhry *et al.*, 1994). After its introduction into the Indo-Pakistan subcontinent around 1904, it has been cultivated in Sindh, NWFP, and irrigated areas of Punjab. Being a leguminous crop, berseem is cultivated in most irrigated belts of Pakistan to fix nitrogen (Stewart *et al.*, 2008), reduce pH of soil, reduce soil alkalinity (Murtaza and Murtaza, 2012), soil salinity, increase soil water-holding capacity and increase aeration by increasing the soil borne Collembola population (Arsen and Jakobsen, 1996).

Due to the increase in human population growth

from 1980 to 2013 (*i.e.*, from 82 to 187 million people), Pakistan needs increased milk and meat production which can only be secured through development of high yielding fodder varieties such as berseem. It contains 18.3% protein, 2.80% phosphorous, 2.60% calcium and 209 ppm carotene which is source of vitamin A. Berseem enhances milk production in animals by providing good nutrition.

Trifolium alexandrinum L. is afflicted by various pests including the important armyworm (Attia, 1968; Clark, 2007; Bashir and Venkatraman, 1968), aphid and leaf miner. Pakistan has a rich fauna because of intensive agriculture since 3000 BCE in the southeast of Asia. So predators and parasitoids of these notorious pests are also found in this region. The major predators and pollinators include the Coccinellidae, a syrphid fly and honey bees. (Shamel, 1956; Naryann *et al.*, 1961; Hussnain 1953).

Farmers in Pakistan use insecticides to reduce armyworm attack but the use of insecticides increases the cost/benefit ratio and adsorption of chlorinated hydrocarbons in adipose tissues of animals provide a source of chlorinated hydrocarbon transfer through the food chain which may negatively affect animals and humans (Peakall, 1996; Blus *et al.*, 1996).

As such there is a need to reduce pesticide use and

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pest management techniques such as host plant resistance, biological control and time of crop harvest may aid in this cause. This research project was conducted to evaluate resistance of berseem cultivar pest attack and to determine the major predators and parasitoids in Multan Southern Punjab Pakistan that may aid in pest management.

MATERIALS AND METHODS

This experiment was conducted at the agricultural farms of the Cotton Research Station near Multan during 2010 and 2011. As soil analysis, done by taking soil sample at the 1-15 cm and 15-30cm through soil sampler, was made before sowing berseem and revealed the soil was a loam. Analysis of soil samples was done at the Soil and Water Testing Laboratory for Research Multan, Agriculture Department of Punjab, Old Shujabad Road Multan.

Plant samples

Seeds of plant samples of different varieties were obtained from Fodder Research Institute, Faisalabad (Ayub Research Institute, Faisalabad). Eleven varieties of berseem were evaluated for their comparative resistance against insect pests. The varieties were anmol berseem, super berseem, agaiti berseem, pachaiti berseem, sandal berseem, Faisalabad 1, Faisalabad 2, P-94, Punjab berseem, Pakistani berseem, chenab berseem. Agaiti berseem, pachaiti berseem and super berseem are standard registered varieties of berseem in Pakistan whilst varieties anmol berseem, sandal berseem, Faisalabad 1, Faisalabad 2, P-94, Punjab berseem, Pakistani berseem and Chenab berseem are newly developed varieties of berseem in Fodder Research Institute which show promise as fodder.

Layout of experiment

Field studies were conducted during 2010-2011 on loam soil in Cotton Research Station, Multan located at 30°12 North, longitude 071 26 East and 122 meter above sea level. In Pakistan, berseem is grown from November to June for fodder. During this period, 6-7 cuttings are obtained. The experiment was laid in a randomized complete block design (RCBD) comprising 11 treatments and three replicates. Plot size was 133.78 square meter.

Soil preparation

Soil was ploughed 2-3 times to make it soft and well pulverized. Stubble of the previous cotton crop was removed. Seed was broadcast at 20 kg/acre. To ensure kansai free seed it was put in 5% NaCl solution and floating Kansai seeds were plucked. This was done

because the Kansai seed deteriorate the quality of fodder. Before sowing, berseem was inoculated with *Rhizobium trifoli*. For this purpose one packet of berseem culture was obtained from soil Microbiology section, Ayub Agricultural Research Institute Faisalabad. Diammonium phosphate (DAP) fertilizer was applied on soil @ 2.5 bag/hectare before sowing December 26, 2012. The first irrigation was applied at the time of sowing, while the second irrigation was applied about 7-10 days after sowing until the end of February. While from March to the last cutting, the crop was irrigated after a 10 day interval, depending upon soil moisture content. No insecticides or plant growth regulators were used to suppress insect pest abundance or enhance yield.

Insect counts

For the purpose of taking insects counts in the field, 0.0929m² rectangular block was made. The block was randomly thrown onto the crop twice at different locations in each treatment. Numbers of target insects, *i.e.*, armyworm, aphids, leaf miners, a syrphid fly and honey bees, were counted from each sample and each sample contained 40-50 berseem plants.

Assessment of yield

Forage yield was determined from each plot after cutting the crop from each treatment then it was converted into per hectare yield (Table III). Seed yield were separated from crop by stick hit method [crop sample of seed put on road and stick was applied on bushel to separate seed from the bushels].

Data analysis

Data was analyzed using Statistix 9.0 software (Statistix 9.0 Analytical software, 2008). Means determined from various treated samples were separated by Least Significant Difference test at 5% level of significance. Line graph were made on the basis of population fluctuation of insects and predators from various observation dates till the time of crop seed harvest.

RESULTS

Berseem varieties resistant to armyworm

The results of comparative resistance experiment clearly reveal that varieties *viz.*, agaiti berseem was significantly susceptible to armyworm attack while pachaiti berseem, P-94, Punjab berseem and super berseem were comparatively resistant to armyworm attack (Table I).

Sampling on different varieties clearly demonstrated that armyworm population had two peaks

in entire crop season. These were between mid-March to mid-April after which the population declined due to cutting berseem for fodder but again peaked in first week of May when the crop was at the bloom stage and pollination was at its peak (Fig. 2). Population dynamics of Armyworm on different varieties demonstrate that population of armyworm rose steadily from 1st week of March to Mid April, 2011, however, 2nd peak was not sharp which may be due to high reduction of pest population at the time of cutting of fodder crop. In Pakistan, a few bird species are good predators of armyworm on berseem crop. These sparrows pick armyworm from stem base on their beaks and carry away pest population. This bird behavior results in sharp reduction of pest numbers at the time of fodder forage crop harvest or cutting time.

Table I.- Relative population of sucking and chewing pests on berseem crop.

Treatment	Pests of berseem		
	Armyworm	Aphid	Leaf miner
Anmol berseem	0.4643 ab	0.2619 b	0.1286 a
Super berseem	0.2143 b	0.5000 ab	0.1381 a
Agaiti berseem	0.6667 a	0.3333 b	0.0000 a
Pachaiti berseem	0.1190 b	0.3810 ab	0.1190 a
Sandal berseem	0.3000 ab	0.7143 a	0.1143 a
Faisalabad 1	0.3571 ab	0.2857 b	0.1905 a
Faisalabad 2	0.3810 ab	0.3810 ab	0.0952 a
P-94	0.1429 b	0.3095 b	0.0476 a
Punjab berseem	0.1905 b	0.5000 ab	0.1476 a
Pakistani berseem	0.2619 ab	0.2286 b	0.2000 a
Chenab berseem	0.2381 ab	0.2262 b	0.1333 a
LSD at 0.05	0.4321	0.3338	0.2659

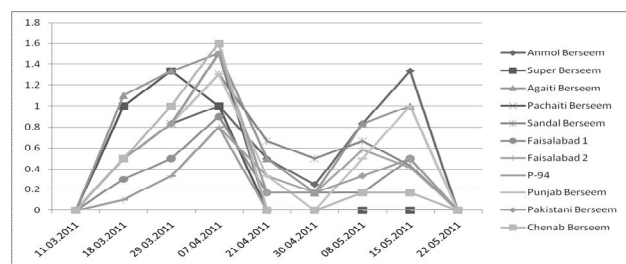


Fig. 1. Population dynamics of armyworm on berseem crop.

Berseem varieties resistant to aphid

Results of present experiment clearly demonstrate population of aphid was at par on super berseem, pachaiti berseem, sandal berseem, Faisalabad 2, and Punjab berseem. However, significantly lower population was recorded on Chenab berseem, Pakistani berseem, anmol berseem and P-94 (Table I). Table II shows the average

performance of berseem cultivars against aphid and armyworms.

Table II.- Performance of berseem cultivars against aphid and armyworm.

Treatment	Armyworm	Aphid
Anmol berseem	Moderately resistant	Resistant
Super berseem	Resistant	Moderately resistant
Agaiti berseem	Susceptible	Resistant
Pachaiti berseem	Resistant	Moderately resistant
Sandal berseem	Moderately resistant	Susceptible
Faisalabad 1	Moderately resistant	Resistant
Faisalabad 2	Moderately resistant	Moderately resistant
P-94	Moderately resistant	Resistant
Punjab berseem	Moderately resistant	Moderately resistant
Pakistani berseem	Moderately resistant	Resistant
Chenab berseem	Moderately resistant	Resistant

The aphid population was highest during March then decreased continuously and reached its lowest level the first week of May, 2011 after which it declined constantly (Fig. 2). Pakistani berseem, pachaiti berseem and anmol berseem had lowest population of aphid throughout the season.

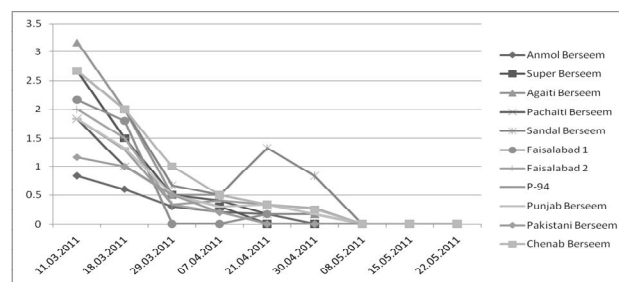


Fig. 2. Population dynamics of aphid on berseem crop.

Berseem varieties resistant to leaf miner

Leaf miner is a minor pest of berseem crop. Its distribution on all varieties was non significant.

Population dynamics studies clearly demonstrates that population of leaf miner had two peaks in mid March and in last week of April. However, population of leaf miner distribution pattern was non-significant (Fig. 3).

Population of coccinellids on various varieties of berseem

Table III clearly demonstrate that population of coccinellid was non-significantly distributed on all varieties of berseem.

In the present studies, coccinellid populations was lowest during the first week of March but rose higher during the last week of March. The population declined

steadily in 1st week of April then surged and reached at its peak in 3rd week of April and 1st week of May. Three peaks of Coccinellids were observed in the entire berseem season (Fig. 4).

Table III.- Relative population of pollinators and predators on Berseem crop.

Treatment	Pollinator and predators		
	Honey bee	Coccinellids	Syrphid fly
Anmol berseem	0.4048 ab	0.5048 a	0.2714 a
Super berseem	0.1429 b	0.1190 a	0.0238 ab
Agaiti berseem	0.3810 ab	0.2857 a	0.0714 ab
Pachaiti berseem	0.4048 ab	0.3571 a	0.0857 ab
Sandal berseem	0.0952 b	0.1190 a	0.0238 ab
Faisalabad 1	0.3810 ab	0.3810 a	0.2619 ab
Faisalabad 2	0.0476 b	0.1429 a	0.0000 b
P-94	0.8571 a	0.3667 a	0.0714 ab
Punjab berseem	0.0714 b	0.2857 a	0.1286 ab
Pakistani berseem	0.1905 b	0.1190 a	0.1190 ab
Chenab berseem	0.2143 b	0.2857 a	0.2381 ab
LSD at 0.05	0.5653	0.3953	0.2632

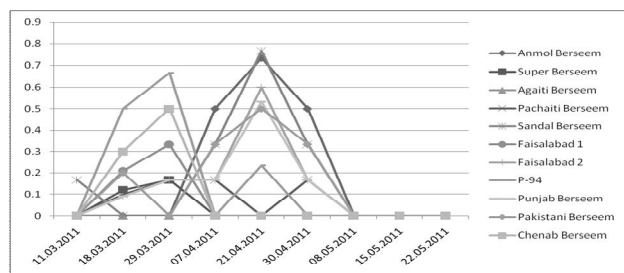


Fig. 3. Population dynamics of leaf miner on berseem crop.

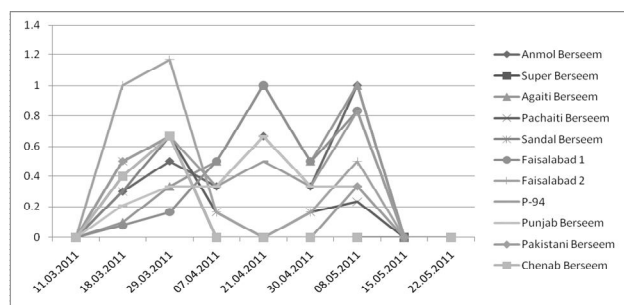


Fig. 4. Population dynamics of coccinellid on berseem crop.

Population of honey bees on various varieties of berseem
Honey bees population was highest at P-94, and significantly lower on Punjab berseem, sandal berseem, Pakistani berseem and chenab berseem.

Honey bee population initiated in the month of March, but attained its peak in the month of April when crop was at bloom stage and suddenly declined after

cutting of berseem crop (Fig. 5). Pollinator again attained its peak in the month of May, 2011.

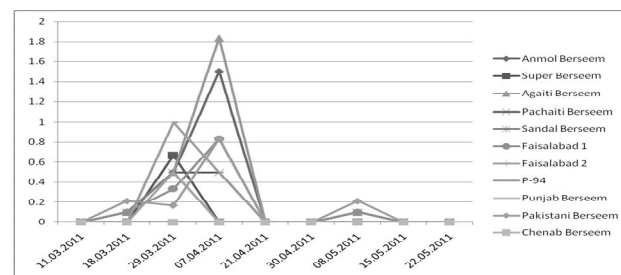


Fig. 5. Population dynamics of honey bee on berseem crop.

Population of syrphid fly on various varieties of berseem

Average syrphid fly population was significantly highest on Anmol berseem. Syrphid fly population was significantly lower at Faisalabad-2. However its population was at par on Super berseem, Agaiti berseem, pachaiti berseem, sandal berseem, Faisalabad 1, P-94, Punjab berseem, Pakistani berseem and chenab Berseem.

Syrphid fly population was initiated in the month of March and then it remained at peak on various varieties as a pest while in the late season predator adult were observed which continued their abundance till the month of Mid May, 2011 (Fig. 3).

Forage and seed yield of berseem varieties

Forage and seed yield of various varieties of berseem was evaluated. It clearly demonstrated that Punjab berseem was at top in terms of forage yield per acre/one cutting and seed yield was 0.66 quintals/hectare which was significantly higher.

Table IV.- Forage yield and seed yield of different varieties of berseem crop.

Treatment	Forage yield (one cutting) kg/ha	Seed yield (g/ha)	Seed yield in quintals/ha
Anmol berseem	8428.2 ab	31112 bc	0.3111 bc
Super berseem	8403.0 ab	11551 c	0.1155 c
Agaiti berseem	8932.3 ab	20323 c	0.2032 c
Pachaiti berseem	7722.3 b	43086 abc	0.4309 abc
Sandal berseem	7873.6 b	32448 bc	0.3245 bc
Faisalabad 1	7621.5 b	58060 ab	0.5806 ab
Faisalabad 2	8377.8 ab	59446 ab	0.5945 ab
P-94	8453.4 ab	61186 ab	0.6119 ab
Punjab berseem	9940.7 a	66606 a	0.6661 a
Pakistani berseem	7621.5 b	36179 abc	0.3618 abc
Chenab berseem	8276.9 ab	34036 bc	0.3404 bc
LSD at 0.05	2.080		

Forage yield was at par on anmol berseem, super berseem, agaiti berseem, Faisalabad 2 and P-94.

However, significantly lower forage yield was observed in pachaiti berseem, Sandal berseem, Faisalabad-1, and Pakistani berseem.

Faisalabad 2, P-94, Faisalabad-1 had seed yield 61186, 59446, 58060 g, which were at par. Anmol berseem, sandal berseem and chenab berseem had seed yield 31112, 32448 and 34036 g, respectively. Super berseem and agaiti berseem had significantly lower seed yield.

DISCUSSION

Berseem is important winter fodder crop in Pakistan which is preoccupied with various minor and major pests *viz.*, Armyworm, leaf minor and aphid. In present work studies were conducted to explore pests, predators and parasitoids fauna associated with berseem crop.

Results of present studies reveal two peaks of armyworm population, one in 1st week of April and 2nd on 1st week of May. Results of present work were in agreement with Bashir and Venkatraman (1968) who reported that population of armyworms reached at its peak in April. We did not notice armyworm population in the month of January on berseem crop. Bashir and Venkatraman (1968) also reported gradual increase of population of armyworm from mid march to April. We also noticed gradual increase of population of armyworm from 1st week of February to mid April. Cutting of fodder on April 15, 2011 reduced pest numbers due to heavy attack of birds which carry away caterpillars in their beaks. So we recommend that one cutting of berseem in mid April results in significant reduction of armyworm population in Pakistan.

Aphid is important minor pest of berseem crop. Mostly it is taken as of negligible importance in Pakistan. However, attack of aphid in Pakistan is significantly higher in February which gradually lowers in preceding weeks due to high temperature and increased coccinellids and syrphid fly population. Similar results were reported by Zeb *et al.* (2011) and Saeed *et al.* (2013) who reported that aphids attack was started in first week of January and was increased during February and March and reached to the peak on 13th March and then the population went down and eliminated completely on all the nine varieties/lines till 6th April.

Leaf miner is a minor pest of berseem crop. Our studies report that its attack was non-significantly distributed on various varieties of berseem crop. Coccinellids are important predators fauna of berseem aphid (Iqbal *et al.*, 2008). In Pakistan, coccinellid population initiates in the month of March and reach at its peak in the month of April and May on berseem, oat,

wheat and other cereal crops. These coccinellids act as important predators of wide range of aphids, onion thrips and eggs of bollworms and leaf worms. Khan *et al.* (2011) elaborated that population of Coccinellids initiates in the month of February and reached at its peak in the month of March on wheat crop we found similar results on berseem crop.

Syrphid fly is important predator of aphid on cereals and vegetable crops. Result of present studies clearly elaborate that population of syrphid fly showed two peaks one in the month of April and 2nd gradual increase in predator adult number as pollinator when crop reached at bloom stage. Most of authors report that syrphid fly population has two peaks.

Honey bees are important pollinators of berseem crop. Honey bees population has two surges which include one gradual increase from mid February to gradual increase till the month of June when majority of bees migrate from plain lands to cool place in search of pollen (Fig. 6). We in the present experiment noticed increased population of berseem when crop was at its bloom stage. The results were similar to Chaudhry *et al.* (1966).

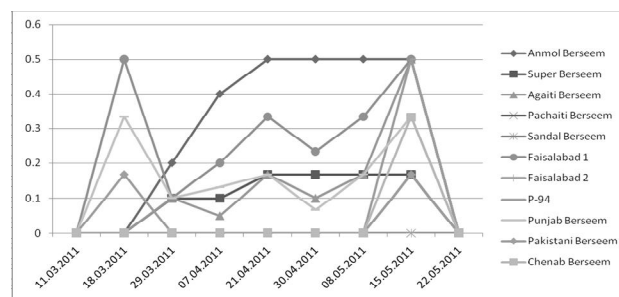


Fig. 6. Population dynamics of syrphid on berseem crop.

CONCLUSION AND RECOMMENDATIONS

Present work elaborates that armyworms, aphid and leaf minor are pests of berseem crop. Pakistan has rich fauna of predators of armyworm which include coccinellids, syrphid fly and birds species. We also recommend that one berseem cutting in mid April relieves crop from heavy build up of armyworm population.

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