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Impact of Soil Potassium on Population Buildup of Aphid (Homoptera: Aphididae) and Crop Yield in Canola (*Brassica napus* L.) Field

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Abstract.- Optimum utilization of fertilizers can play a vital role in pests controlling and increasing seed yield per unit area in combination with other common practices. The field experiment was designed to the probability relating to the potential of potassium application for aphid *Myzus persicae* (Sulzer) infestation in canola *Brassica napus* L., field. Four different doses of Potassium @ 60, 80, 100 and 120 Kg per hectare, including one control were tested to find out its effects on pest build up and grain yield. Observations on number of aphids per plant were recorded at fortnightly intervals starting from the pest invasions. Seed produced per treatment was also recorded at crop maturity. The results indicated that aphid species have been found to flourish more on plants that were grown in soils without potassium. Similarly, it was found that aphid displayed a smaller multiplication rate in soil that was managed with potassium nutrient. Among 4 different doses of potassium, its applications @ 100 and 120 Kg per hectare gave the least number of aphids per plant producing the highest seed yield. Study could lead to conclude that aphid populations may be better managed with the application of potassium @ 100 Kg per hectare for economical production; however, other factors may also be able to contribute to aphid infestations in *Brassica* fields.

Key words: Potassium, fertilizer, aphid, canola, *Brassica napus,* pest prevalence.

INTRODUCTION

Rapeseed, *Brassica napus* L. (Brassicaceae) yields two products, an oil with industrial and edible uses, and a high protein meal used in animal feed. Newly developed variety of rapeseed is marketed as Canola and its oil extracted is used as an edible vegetable oil. The aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae) is an imperative insect pest of canola and occurs frequently in all crop-growing regions of this country. They cause direct feeding damage to plant. However, by colonizing crops, their pace of evolution has accelerated to contend with the chemical control tactics aimed against these pests. This process has resulted in the development of insecticide resistance in aphid species. Until recently, the only mechanism identified was the increased production of carboxylesterases, which cause enhanced degradation and sequestration of insecticidal esters in *M. persicae*. Two forms of target-site resistance were identified involving changes in the acetylcholinesterase and sodium channel genes. This may reflect strong insecticidal selection favouring aphids with multiple mechanisms, tight chromosomal linkage and or the prominence of parthenogenesis in *M. persicae* populations. The decreased fitness of resistant aphids under winter conditions may be a consequence of the altered sodium-channel gene affecting behaviour and or the perception of external stimuli (Alan *et al.*, 1998). Aphids, like most phloem-feeding insects, commonly exhibit a high degree of host specificity. Plant-specific chemical compounds are likely to serve as important host selection cues for monophagous aphids (Dorschner, 1993). Secondary plant substances, also called allelochemicals, play a major role in pest infestations of Brassicaceae species. Glucosinolates and their degradation products are powerful phagostimulants for herbivores feeding on Brassicaceae and deter the noncrucifer feeders but are tolerated by some generalist phytophagous insects such as the *M. persicae* (Frederic *et al.*, 2001).

The strategies to control populations of *M. persicae* are not completely satisfactory for organic crop production. In order to develop an additional control method, scientific trials tended to reduce the presence of this aphid are needed. Fertilizers have played pivotal roles in crop productivity. A correct balance of available essential nutrients substantially

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influences plant health, productivity and nutritional value. The use of only nitrogenous and phosphatic fertilizers is causing potash, sulphur and micronutrient deficiencies restricting the yield potential in plants. In the context of crop intensification and emerging deficiencies of micronutrients, *i.e*. potash and sulphur, the crop yields can be further increased by ensuring that all nutrient deficiencies are met (Ahmad, 2005). The quality of the host plant is important for herbivores feeding on it. Fertilization and nutrient availability can alter the nutritional quality of the plants and this can influence herbivore growth and reproduction (Waring and Cobb, 1992). Most aphids feed directly from the plant phloem and they are considered to be especially influenced by plant conditions such as fertilization and water stress. Host plant quality has been shown to influence both the size and performance of aphids (Dixon, 1998). Therefore, proper uses of fertilizers may correct imbalances or deficiencies in plant nutrients and pest management tactics. Integrating fertilizers within comprehensive plant protection system under field conditions can prove key factor to sustainable pest management strategy. Here, the objective of this research was to evaluate the influences of varying levels of K fertilization on aphid number and final grain yield.

MATERIALS AND METHODS

The experiment was laid on field located at Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan during winter season 2006. The test cultivar W-97-0.75/11 used for this study was quick growing and high yielding under proper field management. Crop sowing was done in the second week of November, after rice had been harvested. The field was properly prepared, weeds and stubbles were cleared, and the land was finally leveled and prepared by laddering. Canola seed was planted after field irrigation, then ploughing and planking at appropriate moisture. Standard agronomic practices were used and the field was hand weeded periodically. The plants were maintained at 10 cm spacing by thinning of plants. The experiment was laid out in a randomized complete block design with three replications and a control plot was also maintained. The plot size was 1 m x 2.5 m (2.5 m^2). None of the replicates were treated with an insecticide during the course of this study.

Generally, the soil was non-calcareous dark grey flood plain, having ECe of 1.3 dS m^{-1}, pH 6.5 to 7.9, Olsen's P 6.7 mg kg^{-1}, organic matter content 0.9%, total nitrogen 0.085%, C/N ratio 13.5 and $CaCO_3$ 10.6%. To ensure a range of K levels in our survey, fields were selected based on previous soil testing, which showed K levels ranging from deficient (80 ppm) to excessive (200 ppm). The land was moderately well drained with silt loam texture. The treatments included four different doses of potassium application *viz.,* 60, 80, 100 and 120 kg potassium/hectare as basal and top dressings, including one control tested to find out its effects on pest build up.

In addition, all five treatments received uniform doses of Nitrogen and Phosphorus applications. A basal and starter dose of N at the rate of 30 kg per hectare as urea was applied to all the treatments at the time of sowing. All plots received an initial application of Triple Super Phosphate @ 40 kg which was incorporated during the final land preparation.

The impacts of different doses of Potassium fertilization was measured on aphid abundance and seed produced by canola crop. The research work included; a survey to quantify the population of the aphid, and to appraise its impacts on seed produced by crop. Pest sampling started when alate aphids migrated into the field, at this time, the canola crop was near flowering stage. The prevalence of aphid (*M. persicae*) per treatment was assessed based on numbers recorded on 5 randomly selected plants, at least one of which had been colonized by the aphids in each replicate from the start of infestation. Data were recorded at fortnightly interval from early February till the mid of March and each plant was visually examined. Yield per plot was also taken to evaluate the loss of plants by the attack of aphid and subsequent effects of treatments. Data on yield were taken from three replicates of each treatment which was as gm per 2.5 m^2 plot and further transformed into kg per hectare. The aphid densities in the survey data and yield were transformed to mean values for analyses. Duncan's Multiple Range Test at 5% level of Probability did statistical analysis for comparison of means.

RESULTS AND DISCUSSION

The population surveys of aphid *M. persicae* at sampling sites undertaken in the field planted variety of canol during different weeks are presented in Fig. 1. Population of aphid was different among all sampling dates; higher number of aphid was found on 15th March as compared to other sampling dates. The pest population was zero in the field at the beginning of February. Aphid colonized the field at mid of February (3.22 aphids/ plant) when crop was at inflorescence stage, but aphid density did not increase until one week later. Density increased rapidly during last week of February, reaching a peak of 23.22 aphids per plant in early March at pods formation. The population declined to a plateau immediately after this peak incidence and then turned down again in mid of March (4.88 aphids/ plant). At crop maturity during late of March, zero aphids population was recorded.

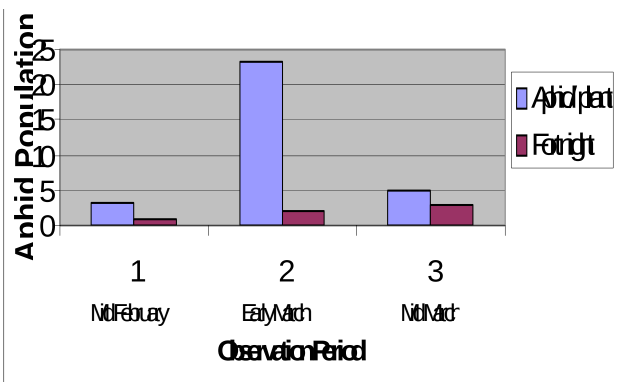

Fig. 1. Aphid population during different growth stages of crop.

Effects of K fertilizer on aphid population

Aphid densities were significantly affected by fertilizer treatments compared with untreated control plants, and this affect was different depending on the type of treatment. But, there was no significant relationship between aphid density and either of Potassium treatments on canola. Generally, there appeared to be a trend of fewer aphid densities with increasing rates of K fertilization. Aphid density was greater in 60 kg K treatment (8.46 per plant) than in the 80 kg treatment (7.63 per plant). Both these treatments had notably more aphids than did the 100 kg K treatment or the 120 kg treatment (4.63 and 4.30 per plant, respectively). Hence, fertilizer treatments did significant affects on aphid densities during sampling periods. The highest prevalence of insect pest was found in the control treatment (13.70 per plant).

Table I.- Impact of soil potassium on population buildup of aphid and crop yield in canola.

S. No.	Potassium treatments (Kg per Hectare)	Aphid population/ plant	Yield/ plot (2.5 m^2) (gm)	Yield Kg per hectare
1.	60 Kg	8.46 b	754.0 b	3016.0
2.	80 Kg	7.63 b	780.0 b	3120.0
3.	100 Kg	4.63 b	875.0 a	3500.0
4.	120 Kg	4.30 b	890.0 a	3560.0
5.	Control	13.70 a	640.0 c	2560.0
LSD value		4.600	74.77	

Means sharing similar letters in columns are non- significantly different (LSD; P = 0.05).

Effects of K fertilizer on grain yield

Grain yield response of canola grown in K fertilizer treatments was variable due to changeable pest intensity and cropping nutrition. Grain yield for control entity was drastically reduced due to increased aphid intensity and deficiency of K nutrition than estimated from normal treatment yields. A statistically significant increased grain yield was recorded from K treated fields than non treated which masked the earlier substantial plant growth response and prevented manifestation of increases in final grain yields. However, canola produced non-significantly (significant at $P = 0.05$) more grain with K fertilizer from 80 kg and 60 kg treatments. As K fertilizer rates increased, there appeared to be better response to minimize pest population and then ultimately grain yield as compared to control plants. Only 640.0 gm per 2.5 m^2 (2560.0 kg per hectare) were obtained on an average for the crop planted without K application after crop harvesting. Grain yields ranged from a maximum of 890.0 gm/ 2.5 m^2 (3560.0 kg/ hectare) to a minimum of 875.0 gm/ 2.5 m^2 (3500.0 kg/ hectare) with both 120 kg and 100 kg K treatments, respectively due to the low pest density. Average yields for the 80 kg and 60 kg treatments were 780.0 gm/ 2.5 m^2 (3120.0 kg/ hectare) and 754.0 gm/ 2.5 m^2 (3016.0 kg/ hectare), respectively.

During sampling period, aphid densities were greater per plant on crop planted in non-treated field than in potassium-applied fields. The only variable that significantly affected pest density was soil treatment with K nutrient. Also, there was a significant relation between pest density and yield of canola. The experiments had shown that due to low aphid population densities, yield was higher in potassium treated crop owing to healthier crop. Almost certainly, process involved for this relationship is that the potassium nutrition of the host plant affected the concentration of nitrogen available through phloem to aphids, which afterward, impacted their abundance. This supports the theories that plant fertilization can be used to reduce insect pests by altering the nutrient quality of their food. Analogous to our study, Myers *et al.*, (2005) in a laboratory-feeding assay examined the effect of K-deficient foliage on life table parameters of soybean aphids *Aphis glycines* Matsumura, and field experiments were designed to determine the effect of three soil K treatment levels on aphid populations and their impact on soybean yields. The feeding assay found that life table parameters differed between aphids feeding on the K-deficient and non-K deficient soybean leaves. Soybean aphids in the K-deficient treatment exhibited significantly greater intrinsic rate of increase, finite rate of increase and net reproductive rate relative to aphids feeding on non-deficient leaves. However, the field experiment showed no significant effect of K on soybean aphid populations, and no significant interaction was observed between aphid abundance and K level on soybean yields in either year. This study therefore suggests that although aphids can perform better on K-deficient plants, yet aphid abundance in the field may be dependent on additional factors, such as dispersal, that may affect final densities within fields. Likewise, Myers and Gratton (2006) observed aphids developing at significantly greater intrinsic rate of population increase and net reproductive rate in the low K treatments in comparison with the medium and high K treatments. In the same experimental fields, naturally colonizing populations of soybean aphids also had significantly higher peak abundance and rate of population increase in the low K treatment compared with medium and high K treatments. In general, these findings indicate that soil K availability and K levels in plant leaf affect plant quality and ultimately may play an important role in soybean aphid population dynamics. Parallel to our results, Walter and DiFonzo (2007) in field surveys examined a higher density of soybean aphids on soybean plants with potassium deficiency symptoms than on plants without deficiency symptoms. This effect was caused due to earlier aphid reproduction and higher number of aphids nymphs per mother on plants growing in lower-potassium soil. In phloem exudation samples, the percentage of asparagine, an important amino acid for aphid nutrition, increased with decreasing soil potassium, perhaps because of potassium's role in the nitrogen use of the plant. A possible mechanism for this relationship is that soybean potassium deficiency improves the nitrogen nutrition of these N-limited insects. By releasing these herbivores from N limitation, host plant potassium deficiency may allow soybean aphid populations to reach higher levels more rapidly in the field. Hence, the results of earlier researchers boost up our findings that addition of potassium to plants can play an important role in reducing pest intensity.

The results of current study show that it is possible to influence aphid abundance with the application of plant fertilization but the influences may vary with both host plant and aphid species. So, this research project has demonstrated that K fertilization can influence grain productivity and insect intensity. Although this research appears to suggest a relationship between canola crop, aphid pest and K fertilization, yet additional studies are needed for further conclusive evidence of these associations. Nevertheless final recommendation for application of supplemental K in soil for *Brassica* production can be made after testing its concentration in soil under natural field condition. This work on impacts of K gives opportunities to better understand interactions of the plant, pest and soil nutrition, but for successful control of pest, integration of other aspects of soil and environment is necessary.

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