Water, Nitrogen and Mineral Losses Caused by Different Weed Species in Rainfed Wheat

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ABSTRACT

Studies on water, nitrogen and mineral losses caused by weeds in rainfed wheat were carried out at the National Agricultural Research Centre (NARC), Islamabad (Pakistan). Among the weed species included in this study, carthamus (*Carthamus oxyacantha* Bieb.) was found to contain the highest percent moisture. Canarygrass (*Phalaris minor* Retz.), although low in density, caused the highest nitrogen loss. Percent nitrogen content of carthamus was the highest, followed by sunspurge (*Euphorbia helioscopia* L.), fumitory (*Fumaria indica* L.), canarygrass and scarlet pimpernel (*Anagallis arvensis* L.), respectively. Weed species showed a similar trend in terms of mineral matter accumulation.

INTRODUCTION

The chief environmental factors in plant competition are water, light and mineral nutrients (Crafts and Robbins, 1973). According to King (1966), weeds accumulate more NPK, Ca and Mg than the crop plants. Based on their preferences for nutrients Singh and Singh (1939) recognised three groups viz., those weeds which are high in nitrogen (including eight members of the Leguminosae); weeds which are high in calcium (especially members of the *Euphorbiaceae* and *Compositae)* and weeds which are high in potassium (the genera *Amaranthus, Cleome, Chenopodium* and *Portulaca*). There are reports that weeds reduce yields of dry land wheat. *Sorghum halepense* and *Xanthium pennsylvanicum* have been known to cause yield reduction in soybean by competing for soil moisture, nutrients and light (Mc Whorter & Hartwing, 1972).

At low fertility levels, both weed and crop growth may be limited but higher fertilization may stimulate weed growth more than the crop plants resulting in increased crop losses (Zimdahl, 1980). Besides, weed growth population diversity has also been found to increase with added rates of nutrients (Banks *et al.*, 1976). This is because of the fact that most of the weeds are more efficient than the crop plants in accumulating considerable amount of the nutrients which results in a competition in favour of weeds and against the crop. In a study, weeds extracted (from the soil) twice as much nitrogen, 25% more potassium and twice as much calcium as the crop plants (Friesen and Korwar, 1983).

Fertility status of the soil has a bearing on the character of the weed flora. Adequately fertilized areas have been noticed to have a preponderance of annual weeds whereas the perennials seem to survive in areas where one or the other of the mineral elements is deficient. The density of weeds is usually more in areas where adequate nitrogen is available and according to Anderson (1983) nitrogen is the first nutrient to become scarce as a result of crop-weed competition: nitrogen defi-

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ciencies being most frequently encountered in agriculture and ornamental horticulture (Ting 1982). In a study, Singh atel. (1976) found no effect of nitrogen on broad-leaved weed population in rainfed wheat.

Water is one of the most critical factors of crop production which determines the crop yield as well as the extent and the character of natural vegetation. On the other hand, weed flora composition is usually an index of the available moisture conditions. Moisture conditions also greatly affect the crop-weed competition particularly in low rainfall areas or tropical areas where there is a distinct dry season. In such environments, a more efficient water utilization by weeds compared to the crop would result in faster weed growth and greater competitive power. In an experiment, Barrett et. al. (1977) showed that two *Chenopodium album* plants used as much water as one corn plant. Similarly, if associated weeds utilized more water than the crop, the limited amount of water in the soil would benefit the weeds more than the crop (Mercado, 1979). *Echinochloa crusgalli, Xanthium pennsylvanicum* and *Digitaria sanguinalis* have the ability to produce vigorous growth and become seriously competitive when adequate soil moisture is available. In semi-arid and arid environment, *Kochia scoparia, Salsola kali, Solanum rostratum* and *Schedonnardus paniculatus* become more troublesome (Wiese and Vandiver, 1970).

The objective of this study was to determine the capabilities of some important weeds of rainfed wheat to accumulate water, nitrogen and mineral matter.

MATERIALS AND METHODS

These studies were carried out at National Agricultural Research Centre, Islamabad. For this purpose, an area of two acres of 'Pak-81' rainfed wheat was selected from where random sampling was done to determine weed density, water, nitrogen and mineral accumulation of five weeds namely *Carthamus oyacantha, Phalaris minor, Anagallis arvensis, Fumaria indica* and *Euphorbia helioscopia.*

To record weed density, 8 quadrates of one square meter each were taken randomly from where counts were made. To determine water, nitrogen and mineral uptake, 20 plants of each weed species were collected randomly 195 days after crop planting.

Only the plant shoots were used for analysis. The N. and Mineral analysis were done on bulked sample of the plants. The density of wheat was 25 plants per meter square. Further work is being carrid out in which the crop and weed analysis at different growth stages is being done simultaneously.

The growth stage, and average height of each weed species are given in Table 1.

Table 1. *Growth stage and height of weeds.*

Weeds	*Stage*	*Height* (cm)
Phalaris minor	Boot	96
Carthamus oxyacantha	Rosette/bolting	33
Euphorbia helioscopia	Flowering/seed	36
Anagallis arvensis	Flowering/seed	29
Fumaria indica	Flowering/seed	59

The collected weed plants were washed, dried on blotting paper weighed and then oven dried. After recording the dry weight, the samples were ground and passed through 20 mm mesh for further determination. Nitrogen contents were determined by Kjeldahl's (1955) method. For mineral matter determination plants were ashed at 500°C and moisture was obtained by drying the samples in the oven as described by Allen *et.al.* (1974). In case of all the determinations, the recorded data were computed to losses caused per hectare according to the following formulae.

$$\text{Moisture (\%)} = \frac{\textit{Loss in weight on drying (g)} \times 100}{\text{Initial sample weight (g)}}$$

$$\text{Total moisture uptake/ha} = \frac{\text{Moisture content} \times \text{Weed biomass/ha}}{100}$$

$$\text{Nitrogen content \%} = \frac{14.0067 \times (\text{ml of trtrant for sample} - \text{ml of tritrant for blank}) \times \text{N of acid}}{\text{Wt of sample (gms)} \times 10}$$

$$\text{Total nitrogen uptake/ha} = \frac{\text{Nitrogen content} \times \text{weed biomass/ha}}{100}$$

$$\text{Mineral content \%} = \frac{\text{Ash weight (g)}}{\text{Oven dry weight}} \times 100$$

$$\text{Total mineral uptake/ha} = \frac{\textit{Mineral content} \times \text{Weed biomass/ha}}{100}$$

RESULTS AND DISCUSSION

Weed Density and Biomass

It was observed that *A. arvensis* was the weed species found in highest density. It was followed by *P. minor*. On the other hand, *E. helioscopia* was recorded in lowest number (Fig. 1).

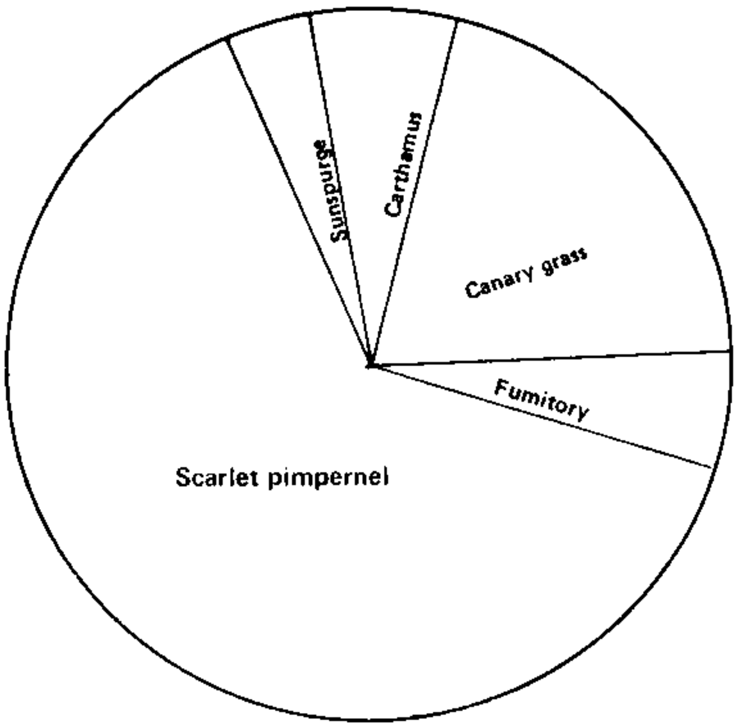

Fig. 1. Density/ha of different weeds

Although the highest weed density was recorded in terms of *A. arvensis* but the highest biomass was shown by *P. minor.* Similarly, *F. indica* although less in number, produced higher biomass than *A. arvensis* (Table 2). This indicates the magnitude of water and nutrient losses caused by different weeds; which is required to build the biomass. As far as the nutrient and moisture losses are concerned, total biomass is more important than the number; unless a particular weed species is absorbing a particular nutrient more than the others or is allelopathic in nature. Weed control measures should be planned keeping in view such factors.

Table 2. Fresh weight and dry weight of five weeds of wheat.

Weeds	*Fresh wt (Kg/ha)*	*Dry wt (Kg/ha)*
Phalaris minor	6102.0	1458.0
Carthamus oxyacantha	150.0	32.3
Euphorbia helioscopia	161.2	16.6
Anagallis arvensis	1172.4	318.2
Fumaria indica	1391.0	351.0

Water Losses

At the time of harvesting of weed plants, *Carthamus* was found to contain 79.8% moisture. Other weeds such as *E. helioscopia*, *P. minor* and *F. indica* showed a moisture percentage of 89.7; 76.1 and 74.8, respectively. The lowest moisture content (72.9%) was recorded in case of *A. arvensis* (Table 3). These observations on moisture contents are important as far as crop stage is concerned. The observations on moisture contents were recorded at a time when the wheat crop was at milk stage; a stage which is most sensitive to soil moisture regimes. To deprive the wheat crop of moisture at this stage can affect the crop yield.

Total water gathered by weed plants at the time of observation was found to be 1644.7 kg/ha. This figure indicates a loss of moisture particularly under rainfed conditions where the crop plants are usually suffering from moisture stress. It indicates only the water stored by weeds at that time, whereas huge amount of water would have already been wasted through transpiration or utilized by weeds in their metabolic process. Under such conditions, efficient weed control can ensure a moisture stress free crop, leading to much higher yields.

Among the weed species, P. minor populations took away the highest quantity of water which is about five times higher than *F. indica* and *A. arvensis*, weeds which ranked second and third in this respect (Fig.2). Least amount of water was taken by *Carthamus* and *E. heloscopia* populations due to low density (Fig. 2) in the former and lower biomass in the later case. In other words, it is the biomass which serves as an important criterion for a species to be categorised for its nuisance value.

Nitrogen Losses

The highest percent nitrogen content was found in *Carthamus*, followed by *E. helioscopia* and *F. indica*. As in case of water content, *A. arvensis* was again found to be the lowest in nitrogen uptake. (Table 3)

A total of 41.5 kg/ha of N was absorved by five weeds investigated in this study. Out of this, more than 65% was shared by *P. minor* populations only. The remaining 35% mainly composed of *F. indica* (19%) and *A. arvensis* (11.57%). *E. helioscopia* contributed 1.20% only to the total nitrogen loss of 41.5 kg/ha (Fig. 2).

Table 3. Water, nitrogen and mineral up take by five weeds of wheat.

WEEDS	CONTENTS (%)			TOTAL UP TAKE (KG/HA)		
	Water	Nitrogen	Minerals	Water	Nitrogen	Minerals
Phalaris minor	76.1	1.9	9.4	1109.5	27.1	137.2
Carthamus oxyacantha	79.8	3.8	15.3	25.0	1.2	5.0
Euphorbia helioscopia	89.7	2.9	10.8	14.9	0.5	1.8
Anagallis arvensis	72.9	1.5	8.5	232.0	4.8	26.9
Fumaria indica	74.8	2.3	9.5	262.5	7.9	33.2
Total				1644.7	41.5	204.1

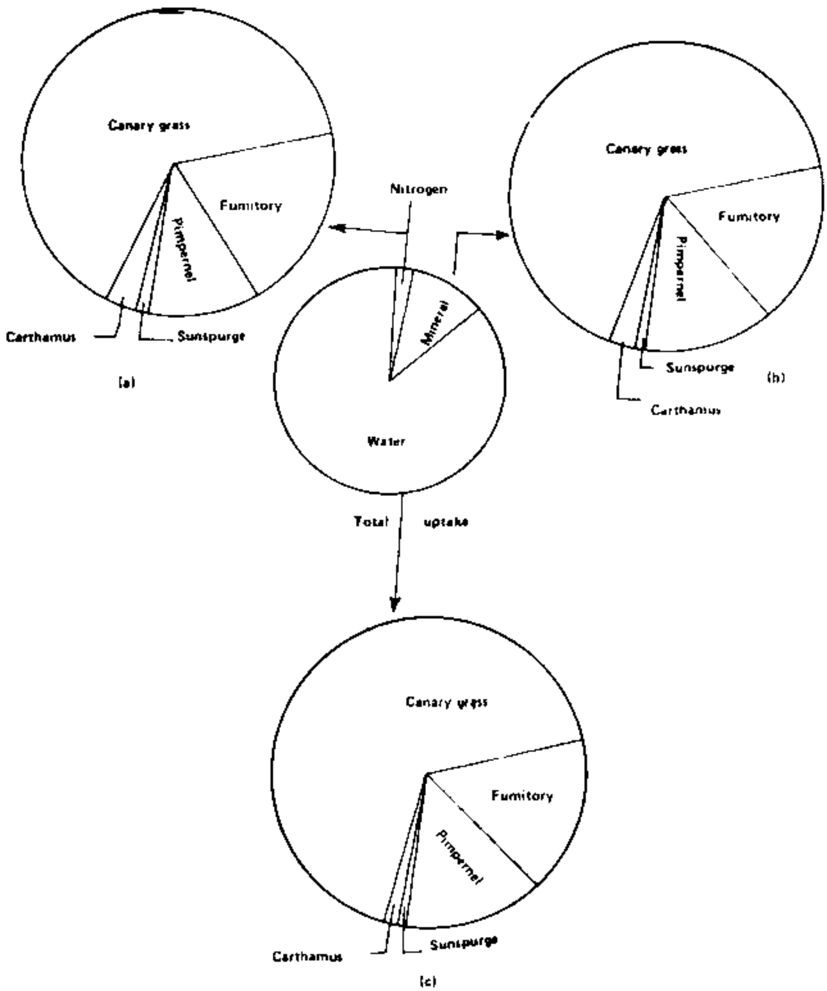

Fig. 2. Water, nitrogen and mineral uptake (kg/ha) by the weeds

The main reason for *P. minor* to be the major user is the high biomass produced by this species although the nitrogen content percent was much less than *Carthamus*. On the other hand, *Carthamus* and *Euphorbia*, in spite of having high nitrogen content, took away the lowest amount of nitrogen per hectare. This is because of the lower densities of these species during this investigation. *A. arvensis*, a species found to be lowest in nitrogen percent content, also gathered a substantial quantity of nitrogen and ranked third in this regard.

It can be concluded from this that a species which can accumulate higher quantities of a nutrient in a particular period of time is harmful even in lower densities. On the other hand, higher densities of another species absorbing lower quantities of the same nutrient should be considered as dangerous.

Mineral Losses

Mineral content as well as total mineral accumulation followed the same trend as in case of nitrogen (Fig. 2). This is also directly correlated to weed biomass. As such, species tending to accumulate higher biomass per unit area through individual size or higher population, should always be the target of weed control measures. At the same time, some species which have special preferences for a particular micro-nutrient can disturb the nutrient balance in the soil and ultimately the crop yields. Likewise, weed species having allelopathic effects should not be ignored while preparing any weed management scheme.

A given parcel of land can produce a limited amount of vegetation in the form of biomass. Our aim should be to have maximum vegetation in the form of crop. Weeds are but plants, having the same nutrient and water requirements as the crop. The nutrients taken up by the weeds increase the cost of production. A point requiring great emphasis is the knowledge of the losses caused by individual weeds. This can help in programming control measures most appropriate for a particular area.

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