Post-Attachment Herbicide Treatment For Controlling Field Dodder (*Cuscuta Campestris* Yuncker) Parasitizing Onion In Gezira State, Sudan

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Abstract: Field dodder (*Cuscuta Campestris*) is an annual obligate stem parasite that attaches itself to a variety of host plants, and is totally dependent on its host plant for assimilating nutrients and water supply. The economic importance of the parasite is due to the fact that it poses a threat to some vegetable crops grown in Gezira State such as onions, tomatoes, jews mallow, and salad rocketand reduces their yield substantially. The objectives of this study were to evaluate the efficacy of post-attachment application of 3 herbicides namely glyphosate, goal and stomp in controlling field dodder parasitizing onion, and to determine their impact on crop yield. The experiments were conducted in 2 locations: in the 1st seasonthe experiment was conducted in a farmer´s field in Alsharafa area, the field was sown in local red onion that was severely infected with field dodder. In the 2nd season the experiment was conducted at the demonstration farm of the Faculty of Agriculture and Natural Resources, University of Gezira, Wad Medani, Sudan. Treatments were arranged in a completely randomized block design with 3 replications. Post-attachment application of stomp at (0.36 kg a.i. feddan^{-1}), goal at (0.1 kg a.i. feddan^{-1}), and glyphosate at (1% v/v) controlled field dodder by 86%-100%, 76%-85%, and 51%-62%, respectively. Dodder treated with stomp exhibited phyllody, stem thickness and it prevented haustorial attachment, and inhibited seed production. During the 2 seasons onion bulb fresh weight, bulb diameterand total soluble solids of herbicides treated dodder-infected onion were significantly increased by (168%-336%), (116%-154%), and (73%-143%), respectively as compared to untreatedcontrol. In conclusion the herbicide treatments controlled field dodder after its establishment which is very important in reducing seed production and stops the parasite spread. Stomp could be recommended for field dodder control as post-attachment application.

Key words: post-attachment, stomp, glyphosate, bulb fresh weight

1. Introduction:

The genus *Cuscuta* (known as dodder) are obligate parasitic plants with approximately 170 species distributed throughout the world (Holm *et al.*, 1997). At least four species are found in Sudan parasitizing broadleaf weeds and some crops in different parts of the country (Andrews 1954; Bebawi 1991; Abdalla and Siddig (1993). Recently Zarouge*t al* (2010) reported the incidence of field dodder (*Cuscuta Campestris*) parasitizing onion in the Gezira scheme in central Sudan, and causing severe losses. Dodder is a nonspecific parasite that attacks, sometimes simultaneously a wide range of host species including many cultivated plant species and dicotyledonous weeds, but not grasses or monocotyledonous weeds (Dawson *et al*., 1994). The dodder seedling coils around the host stems and leaves, penetrates their tissue and vascular system *via* haustoria, and exploits the hostby withdrawing photosynthates and water.Thus, the vigor of the host is lowered and crop production is dramatically reduced. Dodder seeds are likely spread by man, through seed international commerce, movement of equipment, and in the mud ontires and shoes (Cudney and Lanini, 2000).Planting contaminated seed can lead to severe infestations (Parker and Riches, 1993). *Cuscuta pentagona* has been distributed worldwide as a contaminant of alfalfa seed, as both dodder and alfalfa seeds are very similar in appearance.

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Dodder seed has also been spread as a contaminant of flax, linseed, and niger seed (Parker and Riches, 1993). Field dodder management could be achieved using combined preventive, cultural, mechanical and chemical methods that aim at control of existing populations prior to seed production to avoid further dispersal of seeds.Chemical control is the most intensively studied method of dodder control (Dawson 1984, Parker 1991). The best results have been obtained with pre-emergenceapplied herbicides (Cudney*et al*., 1992; Dawson, 1989). Diquat, a contact herbicide, has been used for dodder control in alfalfa and clovers (Gimesi, 1966). Diquat application following forage harvest limits the crop foliage that is damaged, since both crop and dodder are desiccated by this treatment. In a similar way paraquat is used to control dodder, but generally alfalfa is less tolerant, and thus its use is typically limited to spot treatment of small patches (Cudney and Lanini, 2000). The nature of attachment and association between host and parasite requires a highly selective herbicide to destroy the attached dodder without crop damage. Postemergence applications of herbicides such as ethofumesate, pronamide, and pendimethalin can suppress the parasite, but dodder generally recovers (Orloff and Cudney, 1987). Sulfosulfuron at 50 or 100 g ai ha^{-1} was effective to controlfield dodder and safe for tomato while the other sulfonylurea herbicides tested exhibited little or no dodder control (Goldwasser*et al.* 2012).In central Sudan field dodder is often noticed only after attachment to the host, so there is a need to control dodder after its establishment using postemergence herbicides. The objectives of this study were: to evaluate the efficacy of 3 post-attachment application herbicides namely glyphosate, goal and stomp in controlling field dodder parasitizing onion, and to determine their impact on onion crop yield.

2. Materials and Methods

To study the influence of the herbicides on field dodder control and its impact on onion crop yield 2 experiments were conducted as follows:

2.1 On farm experiment:

The 1st season (January 2009) experiment was conducted in a farmer´s field in Alsharafa area in the Eastern bank of the Blue Nile about 2 kms north to Abu Hraz Faculty of Agriculture and Natural resources. The field was sown in local red onion and it was severely infected with field dodder. Treatments were arranged in a completely randomized block design with 3 replications.

2.2 The 2nd season

(January 2010) experiment was conducted at the demonstration farm of the Faculty of Agriculture and Natural Resources, University of Gezira, Wad Medani, Sudan.

2.2.1 The experimental seedlings:

onion seedlings infected with field dodder were collected from infested onion nurseries or fields in Al-sharafa area. Dodder-free onion seedlings of the local red cultivar were obtained from farmers' nurseries in Eastern Gezira where onion is widely grown.

2.2.2 Onion transplanting:

Onion seedlings of about 6 to 8 weeks old of the local red cultivar were transplanted on mid-January in 2010. They were transplanted on ridges 80 cm apart at and within row spacing 10cm, each ridge consisted of 3 rows, subplot size 4m x 3.2m. The subplots were inoculated artificially using dodder-infested onion seedlings. Four infected onion seedlings were sown in each subplot. Control subplots were kept free from dodder infestation. Treatments were arranged in a completely randomized block design with 3 replications. At planting, all plots received a nitrogenous fertilizer in the form of urea (46% N) at a rate of 70 Kg N ha^{-1}. Plants were irrigated once a week. Weeds other than field dodder were controlled by hand every 2 weeks until termination of the experiment.

2.2.3 Herbicide application:

The herbicides,roundup (glyphosate) 0.1%,stomp (pendimethaline) 0.36 kg a.i. $feddan^{-1}$ and goal (oxyfluorfen) at 0.1 kg a.i. $feddan^{-1}$were applied as post-attachment treatment, using knapsack sprayer. Untreated dodder infected onion plot was kept as a negative control along with dodder free onion plot untreated was also kept as a positive control.

2.3 Data collection:

2.3.1 Assessment of field dodder control:

Dodder kill ; phytotoxicity was assessed using the scoring scale 0-4 where 0= 0% control, 1= 1%-25% control, 2= 26%-50% control, 3= 51%-75% control and 4= 76%-100% control.

2.3.2 Assessment of the impact of herbicides treatment on onion:

At harvesting, data were collected on bulb fresh weight, bulb diameter, and number of bulbs per unite area. An area of 1.25m×0.8m of the middle rows was harvested from each subplot. The bulb fresh weight in g/m^2, andnumber of bulbs per m^2 were determined. Then 5 bulbs were selected randomly from each harvested subplot to measure the bulb diameter in cm using verinier, and the total soluble solids (TSS) using refractometer and the average was calculated for further analysis. Analysis of variance was conducted using the General Linear Models Procedure of the Statistical Analysis and treatment means were averaged over the 2 seasons and compared using protected LSD at 5% level of significance. Losses from *C. campestris* in the tested onion cultivars could be assessed by comparing dodder infested plants to dodder free ones. The relative loss (X%) of the growth trait was calculated according to Kroschel*et al.* (1996) as follows:

$$X\% = \frac{C - T}{C} x100$$

Where C is the value of the growth trait in dodder free plants, T is the value of the growth trait in dodder infested plants.

3. Results and discussion:

3.1. The influence of post-attachment application of herbicideson field dodder control:

The 3 herbicides tested in this study considerably controlled field dodder and consequently improved onion yield. Post-attachment application of stomp at (0.36 kg a.i. $feddan^{-1}$), goal at (0.1 kg a.i. $feddan^{-1}$), and glyphosate at (1%) controlled field dodder by 86%-100%, 76%-85%, and 51%-62%, respectively (Figure 1,plate 1).

Plate 1. Dodder infected untreated control (A), Dodder infected treated with stomp as post-attachment

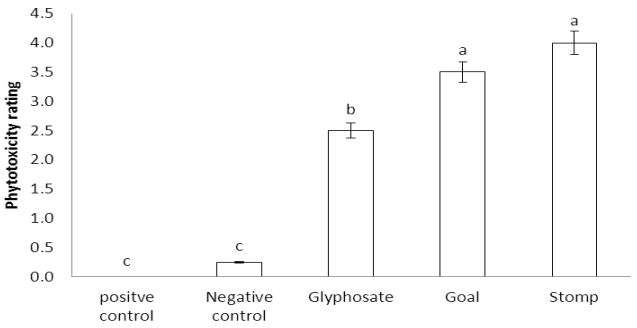

Figure 1. Phytotoxicity of herbicides tested (glyphosate, goal and stomp) on dodder

These findings agreed with Mishra (2009) who reported that dodder can be controlled by using cultural practices, and use of selective herbicides like pendimethalin, fluchloralin and pronamide. However, some of stomp treated dodder plants recovered 3 weeks after treatment. In other studies post-emergence applications of herbicides such as ethofumesate, pronamide, and pendimethalin can suppress the parasite, but dodder generally recovers (Orloff and Cudney, 1987). In this study the recovered dodder plants treated with stomp exhibited phyllody, stem thickness, prevented haustorial attachment and inhibited seeds production as compared to untreated dodder plants (Plate 2).

Plate 2. Dodder plants treated with stomp exhibited phyllody and stem thickness

Similarly, glyphosate at 400 g·ha-1 (a.i.) applied late in the life cycle of carrot when swamp dodder was in full flower, satisfactorily controlled the parasite and increased carrot root yield (Bewick*et al*., 1988). Selectivity of glyphosate may be attributed to the report that phloem-mobile herbicides such as glyphosate, and other AABI applied to the host plant may accumulate selectively in the parasite since it being a stronger sink and inhibit the parasite growth without harming the host (Liu and Fer, 1990; Bewick*et al*., 1991; Liu *et al.*, 1991; Dawson et al., 1994; Nir*et al*., 1996; Nadler-Hassar*et al*., 2002). It was also shown that glyphosate (Fer, 1984; Liu &Fer, 1990; Bewick*et al*., 1991) and imazaquin (Liu *et al.*, 1991) applied to the host foliage accumulated in the apical part of *Cuscuta* in concentrations which are much higher than those found in the apical bud and young leaves of the treated host. Unfortunately, in most cases, host crops were damaged by these treatments (Parker & Riches, 1993; Nir*et al*, 1996) and the parasite was not always adequately controlled (Dawson *et al.*, 1994). In addition, host crops can be injured by glyphosate treatment (Orloff and Cudney, 1987) and the parasite may not be adequately controlled (Frolisek, 1987). Hock *et al*. (2008) reported that glyphosate applied atrates of 140 g/ha controlled field dodder parasitizing ornamental species tested.Liu and Fer (1990) reported that glyphosate applied to the host foliage accumulated in the apical part of dodder in concentrations 26 folds higher than those in the apical bud and young leaves of the host.In alfalfa, Cudney*et al*. (1992) suggested spraying both host and parasite, with a contact herbicide, such as paraquat or by searing with a flame-throwing torch or hand burner. If the infestation is in patches, it can be easily controlled by spraying non-selective herbicides such as glyphosate and paraquat. Some herbicides such as sulfosulfuron at 50 or 100 g ai ha^{-1} was found to be effective and safe for tomato in field dodder control (Goldwasser*et al.* 2012).

3.2.The influence of post-attachment application of herbicides on onion yield:

There was no obvious phytotoxicity on herbicides treated dodder-infected onion crop because field dodder infestation had already produced a thick canopy cover and showed leaf die-back on onion plants prior to herbicide application. These agreed with findings ofNir*et al*., 1996, who reported that imazethapyr and thiazopyr (thiazole herbicide) applied to carrot plants infested with dodder were less damaging than when applied to non-infested carrot, indicating the potential of using low rates of non-selective herbicides for selective control of parasitic weeds. Possibly the herbicide accumulates selectively in the dodder due to its strong sink activity. Post-attachment application of the three herbicides tested consistently improved onion crop yield, which reflects potential using of these herbicide after establishment of field dodder on onion. The herbicide treatments significantly increased onion bulb fresh weight (BFW), bulb diameter (BD) and total soluble solids (TSS) as compared to the untreated dodder-infected onion (Figures 2,3,4). In the 2 seasons onion BFW, BD and TSS of herbicides treated dodder-infected onion were significantly increased as compared with the untreated dodder-infected by (168%-336%), (116%-154%) and (73%-143%), respectively.The BFW, BD and TSS of the untreated dodder- infected onion control were reduced by 94%, 74% and 70%, respectively compared to the positive control.

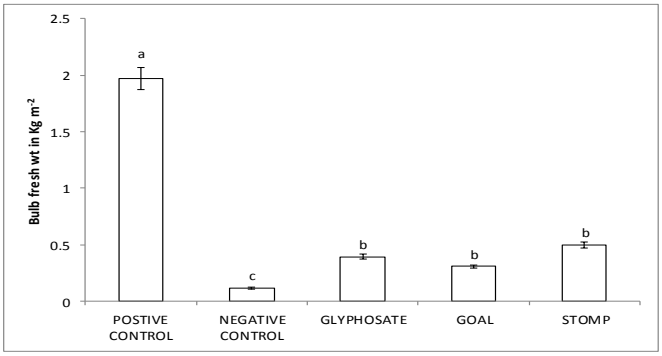

Figure 2. The influence of herbicides tested (glyphosate, goal and stomp) on bulb fresh weight

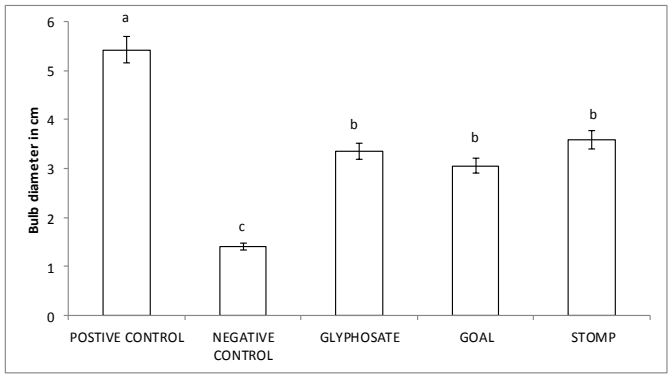

Figure 3. The influence of herbicides tested (glyphosate, goal and stomp) on bulb diameter.

The corresponding reduction in BFW, BD and TSS of dodder- infected onion in response to herbicides treatments were 75%-80%, 34%-44%%, and 26%-48%, respectively compared to the positive control. The results revealed that dodder-infected onion crop was severely damaged prior to herbicide treatments, and the crop yield was significantly reduced as compared with the dodder-free onion. However, the herbicide treatments controlled field dodder after its establishment which is very important in reducing seed production and stops the parasite spread. These findings agreed with Parker (1991) who stated that post-attachment control of the dodder is very important in order to reduce its seed production and further spread, although irreversible damage was already done. There was no significant differences in onion characters tested in response to the herbicides tested. However, stomp consistently gave high BFW, BD and TSS. It was also effective in controlling field dodder. In addition, stomp is among the potent recommended herbicides for weed control in onion in Sudan. Therefore, stomp could be recommended for field dodder control as post-attachment application.

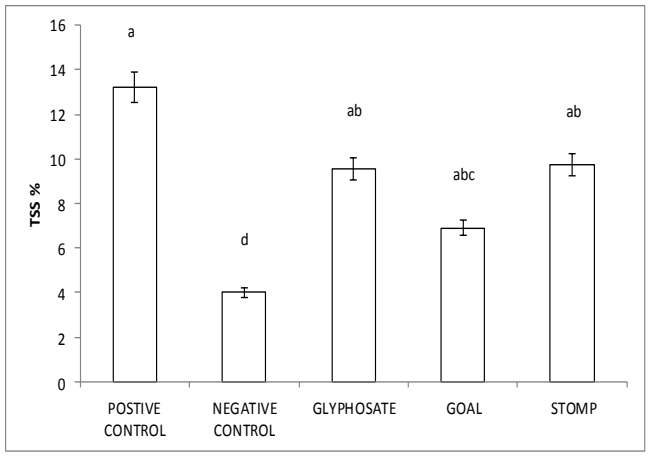

Figure 4. The influence of herbicides tested (glyphosate, goal and stomp) on onion TSS

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