Effects of application methods and dose rates of carbofuran on the control of maize infesting stemborers and consequences on agronomic, yield and yield parameters in central Sudan

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ABSTRACT

This study was conducted at Gezira (GRS) and Sennar Research Stations (SRS) farms during 2014/2015 winter season. Carbofuran was tested in form of "Carbodan 10 G®". The application methods were: Soil dressing method (SDM) applied with the seeds at sowing, top dressing method (TDM) applied into whorls after emergence, and broadcasting method (BM) applied after emergence. The doses were 0.225, 0.3 and 0.375g /hole in SDM and 5.85, 7.8 and 9.75kg/fed in each of TDM and BM. Untreated control (UC) was included in the test. Stemborers damage was assessed on maize leaves and stems. Agronomic, yield and yield parameters were timely recorded. Residue analysis was performed in grains taken at milky and maturity stages. The ordered SDM, TDM and BM showed decreasing trend of dead heart by scoring 6.1%, 5.7%, and 5.5% at GRS, and 7.3%, 4.6% and 3.1% at SRS, respectively, but didn't differ much by effects on leaves. An increasing trend in number of cobs /fed was also evident. All carbofuran treatments reduced percentage of infested plants to a range of 12.6%-16.8% *vs.* 22.4% in the UC at GRS, and 5.2%-15.5% *vs.* 30.5% in the UC at SRS. SDM at 0.375g/hole, TDM at 7.8 kg /fed and BM at 9.75 kg /fed recorded significantly lower percentage of dead heart, 3.7%, 3.8% and 3.6%, *vs.* 14.0% in the UC at GRS, and 9.3%, 2.4% and 4.5% *vs.* 20.1% in the UC at SRS, respectively. They increased plant stand, plant height, number of cobs /fed, 1000-grain weight and grain yield by 32%-105% over the UC at GRS and 46%-175% at SRS. TDM at 7.8 kg /fed produced 2.2 ton /fed which was about three times as much *vs.* UC (0.8 ton /fed) at SRS ($P \leq 0.05$). No residue of carbofuran and its metabolites were detected in all grain samples.

INTRODUCTION

Maize (*Zea mays* L.) is an important crop worldwide. It ranks fourth in acreage and total production in Sudan, after sorghum, millet and wheat and used as human food and important ingredient in animal and poultry feed. Maize is attacked by three major insect pests in Sudan, the spotted (sorghum) stemborer *Chilo partellus* (Swinh) (Lepidoptera: Pyralidae), dura stemborer *Sesamia cretica* (Led) and maize stalk borer *Busseola fusca* (Full) (Lepidoptera: Noctuidae). Maize may harbor some less important minor and occasional insects. According to Abdalla (2000), the predominant stemborer species at GRS farm are *C. partellus* and *S. cretica*, prevailing at relative abundance of 90% to 10%, respectively.

C. partellus is native to Asia where it infests maize and sorghum. Its first record in Africa refers back to 1930 in Malawi, since then it is showing-up in many African countries including Sudan (CAB, 1977). *C. partellus* is present in almost all parts of Sudan, infesting sorghum, maize, millet and many other species of wild grasses (Schmutterer, 1969).

S. cretica is reported in many African, Asian and European countries, infesting sorghum, maize, sugar cane, wheat and rice (Overholt *et al*., 2001). In Sudan, *S. cretica* occurs in the drier irrigated parts, especially in the northern and central parts (Schmutterer, 1969), causing serious damage to sugar cane, and to a lesser extent sorghum and maize (El Amin, 1984). Stemborers are difficult to control, largely because of the nocturnal habits of the adult moths and the protection provided by the stem of the host crop for immature stages (Seshu Reddy and Sum, 1992). Maize yield loss due to stemborers in Africa is 20%-40% of the potential (Khan *et al*., 2003).

In Sudan, winter maize is looked at as a substitute crop to wheat in the irrigated schemes; stemborers damage has been steadily increasing. Although some attempts were made, no measures of control are registered so far. In previous studies, Abdalla (2005) tested carbofuran in form of "Furadan 10 G®" at 0.844, 1.125 and 1.4g product /hole in maize sown in summer and winter seasons of 2004/2005, using SDM. In summer, infestation was low; all carbofuran treatments evenly reduced dead heart to a range of 1.7%-2.2% *vs*. 2.8% in the UC, and scored significantly higher yield, ranging 1050-1181*vs*. 420kg/fed in the UC ($P \leq 0.05$). In winter, infestation was high; the same even performance was achieved; dead heart damage ranged 8%-10.6% *vs*. 14%, and grain yield ranged 754-970 *vs*. 806 kg/fed in the UC, respectively.

The dose 1.125g/hole, had shown the highest yield, and hence, it was repeatedly tested in summer and winter seasons of 2005/2006 for confirmation, using the same SDM (Abdalla, 2006). Summer season had witnessed low infestation, and winter proved once more very high infestation. The dose resulted in complete checking of stemborers throughout summer, by scoring 0% dead heart *vs*. 0.8%, and grain yield of 1098 *vs*.1042 kg /fed in the UC. In winter, the tested dose scored dead heart of 17% *vs*. 40.2% and grain yield of 378 *vs*. 261 kg/fed in the UC, respectively. However, the dose showed severe phytotoxic and retarded growth effects on plants, and hence, it was considered high and not developed as control technique. But, the valuable conclusions achieved constituted base line acquaintance for objectives of this study; to identify suitable application method and appropriate dose rate of carbofuran to safeguard winter maize from stemborers attack with minimum harmful influence on plants, and consequences on agronomic, yield and yield parameters. The study represents part of

the Maize National Program in Sudan, accredited to address the increasing national need for stemborers management in winter maize.

MATERIALS AND METHODS

The study was conducted at GRS and SRS farms during 2014/2015 winter season. A randomized complete block design with four replicates was adopted. Plot size was 16 m^2 at both sites. Sowing of cultivar Hudeiba 2 with one seed/hole, was effected on 21 and 30 November, 2014, respectively, at inter- and intra-row spacing of 80x20 cm. Carbofuran was tested in form of "Carbodan 10®". The application methods were: Soil dressing method (SDM) applied with the seeds at sowing, top dressing method (TDM) applied a week after emergence into whorls, and broadcasting method (BM) applied a week after emergence. All methods were applied manually. The tested doses were: 0.225, 0.3 and 0.375g product/hole, equivalent to 5.85, 7.8 and 9.75 kg/fed, respectively, in SDM, and 5.85, 7.8 and 9.75kg product/fed in each of TDM and BM. The corresponding lower, medium and higher doses in the three methods are equal; in TDM and BM they represent the respective dose/hole in SDM, multiplied by the recommended plant population, *viz*., 26000/fed. Untreated control (UC) was included in the test (Table 1).

Infestation of stemborers, *Chilo partellus* (Swinh) (Lepidoptera: Pyralidae) and *Sesamia cretica* (Led) (Lepidoptera: Noctuidae) was assessed on leaves (rows of irregular holes) and stems (dead heart), nine times at GRS and six at SRS at 7-10 day-intervals and expressed in percentage. Infested leaves were considered those containing one or more number of holes in them. Dead hearts were removed in each count. Agronomic parameters, *viz*., plant stand at harvest, plant height, days to 50% tasseling and silking, first cob height, number of cobs/fed, cobs length, number of grains/cob, 1000-grain weight and grain and straw yield /fed were timely recorded following ARC practices. Irrigation was applied at two week-intervals, weeding, addition of urea at 43kg N/fed and all other cultural practices were timely performed following ARC practices. Residue analysis was performed in grains taken at milky and maturity stages, from the highest dose of each application method, and the UC. The analytical procedure involved solvent extraction of the homogenized grain samples, cleanup on silica gel column and analyses using chromatographic technique with UV detection. The data were transformed when necessary, analyzed using ANOVA and means were separated according to Duncan's Multiple Range Test (DMRT).

Table 1. Treatments: Application methods x carbofuran "Carbodan 10 G®" dose rates.

Carbodan 10G dose	Application method								
	SDM			TDM			BM		
	Tr. no.	Product /hole(g)	g a.i./hole	Tr. no.	product /fed(kg)	g a.i./fed	Tr. no.	Product /fed(kg)	g a.i./fed
25% Lower	1	0.225	0.00225	4	5.85	58.5	7	5.85	58.5
Medium	2	0.3	0.003	5	7.80	78.0	8	7.80	78.0
25% higher	3	0.375	0.00375	6	9.75	97.5	9	9.75	97.5

Tr. = Treatment. Treatment no. 10 = Untreated control. SDM = Soil dressing method. TDM = Top dressing method. BM = Broadcasting method.

RESULTS AND DISCUSSION

Field observations did not reveal phytotoxic and retarded growth effects of carbofuran on plants. Generally, stemborer infestation on leaves and stems at both sites was high; the UC reveals 22.4% and 30.5% infested plants, and 14% and 20.1% dead heart at GRS and SRS, respectively (Tables 2 and 3). This confirmed the findings of Abdalla (2005; 2006), that maize is more subjected to stemborers attacks in winter than in summer season. This is because both stemborer species prefer sorghum more than maize, and sorghum is abundant in summer, hence, maize sown beside sorghum in summer is considered a non-preference crop. In winter, due to absence of sorghum, maize turns into non-choice crop.

Table 2. Percentage of stemborers infested plants at Gezira (GRS) and Sennar Research Stations (SRS) farms, as affected with different carbofuran methods of application and dose rates, winter season 2014/2015

Treatment (dose: by product)	GRS		SRS	
	%	Method average	%	Method average
1. SDM, 0.225 g /hole	(16.2) 4.0	14.2	12.7 b	10.5
2. SDM, 0.3 g /hole	(13.9) 3.6		5.2 c	
3. SDM, 0.375 g /hole	(12.6) 3.5		13.5 b	
4. TDM, 5.85 kg /fed	(12.8) 3.6	14.5	15.3 b	11.8
5. TDM, 7.8 kg /fed	(13.9) 3.7		6.7 c	
6. TDM, 9.75 kg /fed	(16.8) 4.1		13.5 b	
7. BM, 5.85 kg /fed	(14.1) 3.8	14.9	14.2 b	12.2
8. BM, 7.8 kg /fed	(15.9) 4.0		7.0 c	
9. BM, 9.75 kg /fed	(14.6) 3.8		15.5 b	
10. Untreated control	(22.4) 4.7		30.5 a	
Significance	ns.		***	
SE±	0.20		1.1	
CV%	14.5		16.3	

Data was transformed to squire root, and means were compared using DMRT. analyzed. Actual figures in parenthesis. ns.: not significant. SDM = Soil dressing method. TDM = Top dressing method. BM = Broadcasting method. Means within a column followed by the same letter are not significantly different at P≤ 0.01 (***) level of probability according to DMRT.

Table 3. Percentage of dead heart plants, due to stemborers attack, at Gezira (GRS) and Sennar Research Stations (SRS) farms, as affected with different carbofuran methods of application and dose rates, winter season 2014/2015.

Treatment (dose: by product)	GRS Sum of 9 counts/season			SRS Sum of 6 counts/season		
	%		Method average	%		Method average
1. SDM, 0.225 g /hole	(5.2) 2.3	bc		(9.6)	b	
2. SDM, 0.3 g /hole	(9.4) 3.1	ab	6.1	(3.0)	b	7.3
3. SDM, 0.375 g /hole	(3.7) 2.0	c		(9.3)	b	
4. TDM, 5.85 kg /fed	(5.1) 2.3	bc		(8.7)	b	
5. TDM, 7.8 kg /fed	(3.8) 2.0	c	5.7	(2.4)	b	4.6
6. TDM, 9.75 kg /fed	(8.3) 2.9	abc		(2.7)	b	
7. BM, 5.85 kg /fed	(7.0) 2.7	abc		(2.4)	b	
8. BM, 7.8 kg /fed	(5.9) 2.5	bc	5.5	(2.4)	b	3.1
9. BM, 9.75 kg /fed	(3.6) 1.9	c		(4.5)	b	
10. Untreated control	(14.0) 3.8	a		(20.1)	a	
Significance	***			***		
SE±	0.26			2.6		
CV%	20.2			19.9		

Data in first column was transformed to $\sqrt{x+0.5}$. Actual figures in both columns in parenthesis. SDM = Soil dressing method. TDM = Top dressing method. BM = Broadcasting method. Means within a column followed by the same letter (s) are not significantly different at $P \leq 0.001$ (***) level of probability according to DMRT.

The methods averages of infested plants show remarkable reduction in the percentage of infestation which was evident at both sites compared with the UC (Table 2). Slight differences between the three methods were observed at SRS whereas no noticeable differences were observed at GRS site. Similarly, the methods averages of dead heart plants presented in Table 3 revealed remarkable differences at both sites compared with the UC. SDM indicated consistently higher percentage of dead heart plants at GRS (6.1%) and SRS (7.3%) compared to the two other TDM and BM. The latter two methods showed almost similar values of dead heart 5.7% and 5.5% at GRS, and slightly different values at SRS *viz*., 4.6% and 3.1%, respectively. This difference could be justified in assuming that: The mode of carbofuran action when applied as TDM acts through leaves; granules applied into whorls were dissolved by means of dewdrops condensed on cool leaves` surface and transpired water emitted through leaves, allowing carbofuran to get into direct contact with emerged larvae, through short track, and killed them before attacking the stems. In the case of BM, some of the broadcasted granules fall into the whorls and some fall on the soil surface. Here, carbofuran acts through both contact and systemic modes of action. The decreasing trend of dead heart averages reported at both sites, in ordered SDM, TDM and BM, had shown inverse proportional effects in number of cobs /fed, *viz*., 10200, 10700 and 11000 cobs /fed, respectively.

Hence, all methods of application showed remarkable reduction of dead heart plants compared with the UC, and stand as optional for use depending on size of the target area. However, BM showed little superiority over SDM and TDM. In small holdings like "Jabrakas" in South Kordofan State, where farmers grow maize in limited areas around their cottage and in the Northern State and elsewhere, TDM and SDM are much suitable for use. In wide plantations, BM stands as the most appropriate option. However, verification of the possibility of associating BM together with urea application using the tractor mounted broadcasting machine and SDM together with the seeds using the tractor mounted seed box machine are greatly appreciated, as they shall contribute much in ease of the application techniques if prove to be possible.

Regarding carbofuran effects, all treatments reduced percentage of infested plants to a range of 12.6%-16.8% *vs.* 22.4% in the UC at GRS and 5.2%-15.5% *vs*. 30.5% in the UC at SRS (Table 2). This clearly indicated preventive effects of carbofuran that materialized by death of emerged larvae that fed on leaves of treated plants. At the same time, this also indicated that leaves served as first defense front that prevents plant heart from being attacked. This was clearly evident on stems; a highly significant reduction of dead heart plants was observed at both sites compared to the UC ($P \leq 0.01$) (Table 3). The highest dose of SDM (0.375g/hole), the medium dose of TDM (7.8 kg/fed) and the highest dose of BM (9.75 kg/fed) recorded significantly lower percentage of dead heart, 3.7%, 3.8% and 3.6%, *vs*. 14.0% in the UC at GRS, and 9.3%, 2.4% and 4.5% *vs*. 20.1% in the UC at SRS, respectively ($P \leq 0.01$) (Table 3). Comparing infested plants (Table 2) with dead heart plants (Table 3) at both sites, it was persistently evident that in all treatments, including the UC, infested plants were higher than dead heart plants. This indicated that not all emerged larvae that injured the

leaves could reach and damage the stems, largely due to carbofuran fatal effect. These results completely agree with those of many authors. Mir Khan (2000) stated that Furadan 3G (carbofuran) proved significant effect in reducing percentage of dead hearts and pest infestation of maize with *C. partellus* stemborer. Ganguli *et al.* (2013) found that a single application of carbofuran 3G at 7.5 kg/ha in leaf whorl, in a 15 day-old maize crop proved to be the most effective in protection against *C. partellus* stemborer.

An increase in plant stand at harvest was evident in all carbofuran treatments at GRS; plant stand ranged 19.2-25.4 *vs.* 18.8 thousand/fed in the UC. Carbofuran treatments had also increased plant height to a range of 111-130 cm *vs.* 110 in the UC and variations induced by SDM at 0.375g /hole attained significance (P≤0.05). This preservative effect of carbofuran has had its consequences on agronomic, yield and yield parameters. Increases in number of cobs/fed, cob`s length, number of grains/cob and 1000-grain weight were also evident. It is suggested that some maize characters, in particular days to 50% tasseling and silking are more affected by genetic and environmental factors (Tollenar *et. al.*, 1979) (Table 4).

Table 4. Agronomic and yield parameters of maize grown at Gezira Research Station(GRS) farm, as affected by different carbofuran methods of application and dose rates, winter season 2014/2015.

Treatment	Plant stand /fed at harvest (x1000)	Plant height (cm)	Days to 50% tasseling	Days to 50% silking	First cob height (cm)	Number of cobs / fed(x1000)		Cob`s length (cm)	Number of grains /cob	1000-grain weight (g)
						Treatment average	Method average			
1	22.9 ab	123 ab	69	72	59	9.2	10.2	13.7	335	194
2	25.4 a	113 b	68	71	49	10.2		15.7	368	237
3	22.0 bc	130 a	69	72	61	11.2		16.3	355	231
4	19.2 c	124 ab	68	71	59	11.6	10.7	16.0	392	221
5	20.2 bc	123 ab	69	72	60	11.5		150.3	384	221
6	20.4 bc	129 a	69	72	59	9.1		14.0	387	212
7	21.1 bc	119 ab	69	72	62	11.3	11.0	16.7	378	208
8	20.9 bc	111 b	68	71	49	9.0		16.0	300	248
9	20.6 bc	119 ab	69	72	51	12.6		15.7	362	250
10	18.8 c	110 b	68	71	50	8.8		14.3	310	191
Sig.	*	**	ns	ns	ns	ns		ns	ns	ns
SE±	1143	4.4	0.3	0.3	3.6	1460		0.9	30.9	15.2
CV%	9.4	6.4	0.8	0.8	11.3	24.2		9.9	14.7	11.9

Treatments as indicated in Table 2. Means within columns followed by the same letter (s) are not significantly different at P≤ 0.05 (**) and P≤ 0.01 (*) level of probability, according to DMRT. ns. : Not significant.

With regard to grain yields, all carbofuran treatments out-yielded the UC by 32-105% at GRS and 46-175% at SRS. The yield recorded by the medium dose of TDM (7.8 kg /fed) (2.2 ton/fed) at SRS, was almost three times as much as that of the UC (0.8 ton/fed) and variation attained significance at P≤0.05. Straw yield was also increased by most of carbofuran treatments, and the highest dose of SDM (0.375 g /hole) recoded significantly the highest straw yield, *viz*., 1.92 ton /fed, *vs*. 1.32 ton /fed in the UC ((P≤0.1) (Table 5). These results came in full harmony with those of Abdalla (2000; 2005; and 2006) and Mir Khan (2000). The latter author stated that Furadan 3G used for the control of *C. partellus* stemborer in maize proved significant increase of stalk, cobs weight, average number of cobs/plant and grain yield compared to the check. Studying the effects of carbofuran at 1.0 and 1.5 kg a.i/ha on agronomic and yield parameters in *C. partellus* infested maize zones in Nigeria, *Okweche et al. (2013)* reported significant increase in plant height and yield and reduction of the stemborer. Studies in India, resulted in significantly less numbers of *C. partellus* infested maize plants and higher grain yield in carbofuran treatment at 15 kg/ha compared to other treatments (Pradyumn and Sharma, 2009).

Table 5. Grain yield of maize grown at Gezira Research Station (GRS) and Sennar Research Station (SRS) farms, and dry straw yield at GRS farm, winter season 2014/2015.

Treatment (dose: by product)	Grain yield, (ton /fed)		Dry straw yield, GRS (ton /fed)
	GRS	SRS	
1. SDM, 0.225 g /hole	0.75	1.17 bc	1.68 abc
2. SDM, 0.3 g /hole	1.08	1.95 ab	1.90 a
3. SDM, 0.375 g /hole	1.17	1.45 abc	1.92 a
4. TDM, 5.85 kg /fed	0.89	1.22 bc	1.24 cd
5. TDM, 7.8 kg /fed	1.05	2.20 a	1.80 ab
6. TDM, 9.75 kg /fed	0.86	1.62 abc	1.54 abcd
7. BM, 5.85 kg /fed	0.85	1.22 bc	1.56 abcd
8. BM, 7.8 kg /fed	0.78	1.75 ab	1.11 d
9. BM, 9.75 kg /fed	0.93	1.61 abc	1.52 abcd
10. Untreated control	0.57	0.80 c	1.32 bcd
Significance	ns	**	*
SE±	0.15	0.21	0.16
CV%	29.2	28.3	18.4

SDM = Soil dressing method. TDM =Top dressing method. BM = Broadcasting method. Means within columns followed by the same letter (s) are not significantly different at P≤ 0.05 and P≤ 0.01 levels of probability, according to DMRT.

No residues of carbofuran and its metabolites were detected in grain samples; thus, the use of granulated carbofuran for control of stemborers in maize is safe at the recommended methods of application and dose rates.

CONCLUSION

Carbofuran, in form of "Carbodan 10G®", proved efficiency in suppressing stemborers in maize; the highest dose applied as soil dressing with the seeds (0.375g product/hole, equivalent to 9.75 kg/fed), the medium dose applied into whorls after emergence as top dressing (7.8kg product/fed) and the highest dose applied around stems after emergence as broadcasting (9.75 kg product /fed) markedly reduced leaves and dead heart damage. All methods of application showed remarkable reduction of dead heart plants, hence, they are suggested as optional for use in accordance with the size of target area and suitability of timing of application. Carbofuran had also improved agronomic and yield parameters, and increased grain and straw yield. However, BM showed little superiority over SDM and TDM.

RECOMMENDATIONS

Carbodan 10G® (carbofuran) is recommended at the following methods of application and dose rates for the control of maize infesting stemborers *Chilo partellus* and *Sesamia cretica*:-

1. As soil dressing, applied with the seeds at sowing, at 0.375g product /hole (0.00375g a.i./hole) equivalent to 9.75 kg /fed (97.5g a.i./fed).
2. As top dressing, applied into whorls after emergence, at 7.8 kg product /fed (78.0g a.i./fed).
3. As broadcasting, applied around stems after emergence, at 9.75 kg product /fed (97.5 g a.i./fed).

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تأثير طرق الإضافة وجرع الكاربوفيوران في مكافحة ثاقبات سيقان الذرة الشامية وإنعكاسات ذلك علي المعايير الفلاحية والإنتاجية في وسط السودان

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[2] هيئة البحوث الزراعية، محطة بحوث سنار، سنار، السودان.

الخلاصة

. اختبر الكاربوفيوران 2015/2014 أجريت هذه الدراسة بالحقول التجريبية لمحطة بحوث الجزيرة ومحطة بحوث سنار خلال موسم شتاء)، واختبرت طرق الإضافة: داخل التربة مع البذور عند الزراعة والإضافة داخل قمع Carbodan 10Gفي تجهيزته التجارية (جم/ للحفرة في طريقة الإضافة داخل 0.375 و0.3 و0.225النبات بعد الإنبات وطريقة النثر بعد الإنبات. الجرع المختبرة: كجم/للفدان في كل من الطريقتين الأخريين. تمت إضافة شاهد غير معامل للمقارنة. تم رصد إصابة 9.75 و7.8 و5.85التربة، و ثاقبات الساق علي كل من الأوراق والسيقان. تم أخذ البيانات الفلاحية والإنتاجية في مواعيدها، كما وأجري فحص لمتبقيات الكاربوفيوران في الحبوب المأخوذة في طوري اللبنة والنضج. أظهرت طرق الإضافة داخل التربة وداخل القمع والنثر اتجاه 3.1% و4.6% و7.3% في محطة بحوث الجزيرة و5.5% و5.7% و6.1%متناقص لموات الساق الأساسي للنبات بتسجيلها بمحطة بحوث سنار علي التوالي، وصاحب ذلك اتجاهاً في زيادة عدد الكيزان في الفدان، ولكنها لم تظهر اختلافاً بتأثيرها علي مقابل 16.8%-12.6الأوراق. أدت جميع جرع الكاربوفيوران الي خفض النسبة المئوية للإصابة علي الأوراق لمستوي في الشاهد، في محطة بحوث سنار. أظهرت 30.5% مقابل 15.5%-5.2 في الشاهد في محطة بحوث الجزيرة و22.4% كجم 9.75 كجم للفدان في طريقة الإضافة داخل القمع، و7.8جم/ للحفرة في طريقة الإضافة عند الزراعة، و0.375الجرعة 14.0%% مقابل 3.6 و3.8% و3.7%للفدان في طريقة النثر انخفاضاً معنوياً في نسبة موات الساق الأساسي للنباتات مسجلة للشاهد في محطة بحوث سنار، علي التوالي. أدت 20.1% مقابل 4.5% و2.4% و9.3%للشاهد في محطة بحوث الجزيرة و جميع جرع الكاربوفيوران الي زيادة عدد النباتات عند الحصاد، طول النباتات، عدد الكيزان في الفدان و وزن الألف حبة وفي في محطة بحوث سنار. انتجت 64%-175% فوق الشاهد في محطة بحوث الجزيرة و32%-105%انتاجية الحبوب بنسبة طن للفدان، مسجلة بذلك زيادة بحوالي ثلاثة 2.2 كجم للفدان عند طريقة الإضافة داخل القمع في محطة بحوث سنار 7.8الجرعة طن/للفدان) وبمعنوية عالية. لم يظهر اختبار متبقيات المبيدات وجود أي متبقيات 0.8أضعاف ما انتجه الشاهد غير المعامل (للكاربوفيوران او لأي من تحولاته في حبوب الذرة الشامية.